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Supplement

to the Proceedings of the

42nd Annual Symposium on Frequency Control 1988

Subject and Author Index

for the Proceedings

of the 10th to 42nd

Symposia on Frequency Control

and

Symposium Historical Information

1946 - 1988

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Background and Early Sessions of the Frequency Control Symposium

Willie L. Doxey, retired*

The commitment of the Chief Signal Officer in early 1940 to equip the Army Combat Forces with radio communications using piezoelectric quartz crystals for frequency control was indeed a bold, yet sound, decision. The initial engineering development, prototype models, and field testing proved conclusively that the quartz crystal was essential to assure the military of reliable communications under combat conditions. However, adequate information was not available at that time to properly expose the astronomical problems of expanding and modernizing an industry capable of producing the number and variety of quartz crystal units to meet mobilization schedules for communications equipments required by the Armed Forces. Cursory inventory of the total production of quartz crystals (of all types) in the years of 1939 and 1940 turned out to be, at most, only a few thousand compared to the several million required at the beginning of 1942. During a special review of this critical production problem, a suggestion was made by the Senior Field Commander of the Armored Forces (on maneuvers at the time) to return to the old model radio without the use of quartz crystals. At this remark, General James D. O'Connel stated, with some authority: "Yes, we can give you those radios; but with quartz crystals we can give you communications."

During the war years of 1942-45, the crystal manufacturers, with unstructured support of the three services (Army, Navy, and Air Force), sponsored "production forums" which met monthly, in conveniently located cities, for discussions of those problems related to the production, testing, packaging, etc., of crystals for the military services. These meetings provided a valuable communications network and, more important, provided a platform for exchanges of technical information and production problems in this narrow field of new technology. After the war, however, only a relatively few of the crystal companies remained active. Military requirements for production (of existing types) were simply nonexistent.

During the last years of war (1944-45), the three services (Army, Navy, and Air Force), and the National Bureau of Standards, along with the Bell Telephone Laboratories, and universities (among others), had become more keenly aware of the lack of scientific knowledge of the properties of the quartz crystal. Interest and support expanded rapidly in the military services to provide resources for research and development, as well as refined techniques and equipment for the production of piezoelectric devices. All three services expanded their fiscal capabilities to include sizeable research and development of internal and contractual programs to meet their projected, new and improved crystal requirements. The Army program, keynoted by positive direction of General James D. O'Connel to wit, "We must never again be caught, as we were in 1941-42, without a superior base of technology, trained engineers, and upgraded facilities to accomplish the Army's mission in communication on a timely basis."

With the support and direction of General O'Connel (who subsequently became Chief Signal Officer of the Army), several actions were made possible:

1. Funding for frequency-control programs for research and development contracts was increased substantially, exact figures are not available. However, if we suggest a figure of one and one half million dollars, as an initial start (with the buying power of 1946 dollars), this was considered a very worthwhile effort.

2. The Fort Monmouth Frequency Control Activity, at the close of World War II, retained its identity, thus surviving serious reductions in personnel, particularly engineers and technicians.

3. The Army's Frequency Control activities (internal and external) have survived a number of command reorganizations (or restructurings), and maintain a very healthy "Laboratory" identity.

Throughout the World War II years of 1941 through 1945, production of war support materiel was of the highest priority. Engineers and technicians were totally engaged in production support. The quartz crystal production program was among the 10 highest priority items in the total Army program. Engineers in the crystal industry (and in the government) identified problems in the design, production, and performance of crystal units (as well as test and measurement equipment), which required research and development efforts. As a result, when the war ended, there was an abundance of proposed tasks and projects requiring development work, engineering design (redesign), and research investigations. Unsolicited proposals were being received by R&D activities of all three services (Army, Navy, and Air Force), and in many instances the same proposal found its way into each of the services for support. Although coordination among the three services was very good, at laboratory levels, the potential, as well as actual overlap and duplication of efforts, suggested/demanded a coordinated review at laboratory levels on an annual basis by engineering and top management personnel from the three services.

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*Willie L. Doxey was Chief of the Frequency Control Branch, Signal Corps Engineering Laboratories, Fort Monmouth, NJ, during the early days of the Symposium, prior to the publication of the first Proceedings.

In the absence of a structured organization to review and coordinate the research and development in this new and important field of Frequency Control, representatives of the Army, Navy, and Air Force (with participation of the National Bureau of Standards, experts from commercial R&D laboratories, and manufacturers), initiated action to formalize an annual review of problems, progress, and programs in this rapidly growing field of frequency control.

The first "Conference on Frequency Control" was held in 1946 in the conference room of Squire Signal Laboratory, Fort Monmouth, NJ, under Signal Corps sponsorship, with the participation of Air Force, Navy, and industry. Approximately 65 people attended. The agenda was flexible, with informal presentations by engineers of the three services, covering, primarily, their internal programs and contractual requirements, followed by a tour of the facilities and internal activities of the Frequency Control Branch of Squire Signal Laboratory. Informal presentations were made by engineers from R&D contractors and other technical representatives from commercial manufacturers and laboratories. Interesting and profitable discussions followed each presentation. Attendees expressed opinions that this technical meeting was very worthwhile, and that a similar meeting should be held annually. No formal reports were prepared; however, the informal notes and discussions proved valuable. The next three annual reviews were also held at the Fort Monmouth facility. Attendance increased substantially each year, and soon exceeded the capacity of facilities available at Fort Monmouth. The conferences were then held at the Berkeley-Carteret Hotel in Asbury Park, NJ, where they were entitled Symposium. Invitations and formal agenda were prepared and issued by the Frequency Control Branch; however, no proceedings were prepared of the first nine symposia. Beginning with the 10th Frequency Control Symposium, formal papers were required, and proceedings were prepared and distributed.

The major technical areas of research, development and production explored during the first nine Frequency Control Symposia were as follows:

- Quartz Crystals
- Other Crystals Having Piezoelectric Properties
    - Such as: Tourmaline, Aluminum Phosphate, Nepheline
- High Pressure Crystal Growing Techniques
- Defects in Quartz
- Piezoelectric Oscillators
- Processing Technology
    - Plating (Materials)
    - Polishing
    - Mounting, etc.
- Crystal Holders
    - Metal, Phenolic, Glass
- Hermetic Sealing
- Aging Studies
- High Precision Crystals and Oscillators
- Temperature Control (Ovens)
- Mass Production - Techniques, Equipments, Automation
- Measurement Methods

Atomic and molecular frequency standards were first addressed at the Symposium in the mid-1950's.

The symposium remained at the Berkeley-Carteret Hotel until 1959; after which time it was transferred to the Shelburne Hotel in Atlantic City, NJ, where it remained until 1971. The Symposium soon reached an attendance of several hundred engineers and scientists from a number of domestic and foreign countries.

In 1972, the Symposium moved to the Howard Johnson's Motor Lodge in Atlantic City. In 1973, due to a major fire at the Howard Johnson's a few months prior to the Symposium, the Symposium was moved to the Cherry Hill Inn, Cherry Hill, NJ. In 1974, the Symposium returned to Howard Johnson's, and remained there until 1979 (which is about the time that gambling became legal in Atlantic City). From 1980 to 1987, the Symposium was held in Philadelphia, PA.

Sponsorship and management of the Symposium remained with the leadership of the Frequency Control Branch of Fort Monmouth, NJ until 1981. There was no registration fee charged up to 1981. Because the costs, in terms of both manpower and dollars, became an increasing burden on the Frequency Control Branch, a contractor was hired in 1981 to assist with the administrative aspects of the Symposium, and a registration fee was instituted in 1982. By this time, the Symposium had long ago developed into the premier international scientific and engineering meeting in the area of frequency control. Discussions of defense related frequency control issues were no longer the focus. In 1983, a Memorandum of Understanding for cosponsorship of the Symposium was signed between the Director, U.S. Army Electronics Technology and Devices Laboratory and the President, Institute of Electrical and Electronics Engineers, Sonics and Ultrasonics Group. The Sonics and Ultrasonics Group changed its name shortly thereafter to the IEEE Ultrasonics, Ferroelectrics and Frequency Control Society.

As long as the Frequency Control Branch provided the manpower for administering the Symposium, it was necessary for the Symposium to be located in the vicinity of Fort Monmouth, NJ. With the changes implemented between 1981 and 1983, this was no longer essential. The Symposium management, therefore, decided to change the Symposium location annually, starting with the 1988 Symposium.

Symposium Chairmen, 1956-1988

Year	General Chairman	Technical Program Chairman	Other
1956	Eduard A. Gerber	Personnel of the Frequency Control Branch, US Army Signal Corps Engineering Laboratories	
1957	Eduard A. Gerber	J.M. Havel, R. Bechmann, M. Bernstein, G.K. Guttwein, F.H. Reder	Arrangements: Clarence E. Searles, Ruth C. Jenny
1958	Eduard A. Gerber	Jerome M. Havel	Arrangements: Clarence E. Searles, Ruth C. Jenny Facilities: Millard F. Timm
1959	Eduard A. Gerber	Jerome M. Havel	Arrangements: Clarence E. Searles Facilities: Millard F. Timm
1960	Eduard A. Gerber	Jerome M. Havel	Arrangements: Clarence E. Searles Facilities: Millard F. Timm
1961	Eduard A. Gerber	Jerome M. Havel	Arrangements: Clarence E. Searles Facilities: Millard F. Timm
1962	Eduard A. Gerber	Jerome M. Havel	Arrangements: Millard F. Timm
1963	Eduard A. Gerber	Gunter K. Guttwein	Arrangements: Millard F. Timm
1964	Eduard A. Gerber	Gunter K. Guttwein	Arrangements: Millard F. Timm
1965	Eduard A. Gerber	Gunter K. Guttwein	General Vice Chairman: Vincent J. Kublin Executive Assistant: Millard F. Timm Publications & Publicity: Mrs. P. Goldon Local Arrangements: Millard F. Timm
1966	Vincent J. Kublin	Gunter K. Guttwein	Executive Assistant: Millard F. Timm Publications & Publicity: Marilyn Herberg Local Arrangements: Millard F. Timm
1967	Vincent J. Kublin	Gunter K. Guttwein	Executive Assistant: Millard F. Timm Publications & Publicity: Marilyn Herberg Local Arrangements: Millard F. Timm
1968	Vincent J. Kublin	Gunter K. Guttwein	Executive Assistant: Millard F. Timm Publications & Publicity: Marilyn Herberg Local Arrangements: Arthur D. Ballato
1969	Vincent J. Kublin	Gunter K. Guttwein	Executive Assistant: Millard F. Timm

Year	General Chairman	Technical Program Chairman	Other
			Local Arrangements: Joseph M. Stanley
1970	Vincent J. Kublin	Gunter K. Guttwein	Executive Assistant: Joseph M. Stanley Staff Consultant: Millard F. Timm
1971	Vincent J. Kublin	Gunter K. Guttwein	Executive Assistant: Joseph M. Stanley Staff Consultant: Millard F. Timm
1972	Vincent J. Kublin	Erich Hafner	Executive Assistant: Joseph M. Stanley Staff Consultant: Millard F. Timm
1973	Milton Tenzer	Erich Hafner (ECOM) A.R. Chi (NASA)	Executive Assistant: John Vig
1974	Milton Tenzer Erich Hafner	Erich Hafner	Executive Assistant: John Vig
1975	Milton Tenzer Erich Hafner	Erich Hafner	Exec. Asst.: John Vig Secretary: Lee Hildebrandt
1976	Milton Tenzer Erich Hafner	Erich Hafner	Executive Assistant: John Vig Secretary: Lee Hildebrandt
1977	Erich Hafner	Erich Hafner	Executive Assistant: John Vig Executive Secretary: Lee Hildebrandt
1978	Erich Hafner	Erich Hafner	Executive Assistant: John Vig Executive Secretary: Lee Hildebrandt
1979	Erich Hafner	Erich Hafner	Executive Secretary: Lee Hildebrandt
1980	Erich Hafner	Erich Hafner	Executive Secretary: Lee Hildebrandt
1981	Erich Hafner	Erich Hafner Arthur Ballato	Executive Secretary: Lee Hildebrandt
1982	Vladimir G. Gelnovatch	Arthur Ballato	
1983	John R. Vig	Samuel R. Stein	
1984	John R. Vig	Samuel R. Stein	
1985	John R. Vig	Samuel R. Stein	Finance Chairman: Thomas Parker
1986	John R. Vig	Leonard S. Cutler	Finance Chairman: Thomas Parker Publicity Chairman: Raymond Filler
1987	John R. Vig	Leonard S. Cutler	Finance Chairman: Thomas Parker Publicity Chairman: Raymond Filler
1988	John R. Vig	Thrygve R. Meeker	Finance Chairman: Raymond Filler Local Arrangements Chairman: Michael Driscoll

Symposium Awards, 1966-1988

From 1966 to 1982, only one award, the C.B. Sawyer Memorial Award, had been presented at the Frequency Control Symposium. According to the Sawyer Award announcement, the Award is "to consist of $500.00 and a plaque, shall be made on an annual basis to the person, or the group of persons, who, in the opinion of an independent three-man judging committee, has made the most outstanding recent contribution to advancement in the field of quartz crystals and devices. No award will be made in a year in which the committee determines that no award is warranted. Presentations will be made at the Frequency Control Symposium."

Aside from permitting the presentation of the Sawyer Award at the Symposium Banquet, the Symposium's management has had no involvement with the Sawyer Award. The Award is sponsored by Sawyer Research Products, Inc.; the judging committee is selected by that company. The first Sawyer Award was presented in 1966. It has been presented each year since then, except in 1982, when no suitable award nominations were received.

In the early 1980's, sentiment was expressed at Symposium program committee meetings for the creation of awards to recognize outstanding contributions in all fields covered by the Symposium, not just in the field of quartz crystals and devices. Therefore, in early 1983, the program committee voted to create two new awards. One, the Cady Award, named after Walter Guyton Cady, is to recognize outstanding contributions related to piezoelectric frequency control devices. The other, the Rabi Award, named after Prof. I.I. Rabi, is to recognize outstanding contributions related to fields such as atomic and molecular frequency standards, and time transfer and dissemination. Each award consists of $500.00, and a limited edition original print and certificate in a leather binder. The awards are presented to the recipients at the Symposium.

SAWYER AWARD WINNERS, 1966 to 1982:

1966 - Warren P. Mason: "For outstanding contributions in quartz crystal devices, particularly in the field of frequency selection" and
Rudolf Bechman: "For outstanding contributions in quartz crystal devices, particularly in the field of frequency control."

1967 - Raymond D. Mindlin: "For fundamental contributions to the theory of vibration in piezoelectric resonators leading directly to advancements in the art."

1968 - Daniel R. Curran: "For original and imaginative design of multielectrode piezoelectric resonators, contributing significantly to the rapid advance of the quartz filter art in the past few years" and

David B. Fraser: "For contributions to the knowledge of the mechanisms of acoustic loss in crystalline quartz, and the evaluation of this acoustic loss by optical methods."

1969 - Arthur W. Warner, Jr.: "Contributions to the development of high frequency thickness shear quartz resonators for precise frequency control and as an aid to the measurement of the intrinsic Q of quartz material."

1970 - Issac Koga: "Theoretical and experimental investigations of quartz and tutorial leadership in the field of piezoelectric crystals."

1971 - Donald L. Hammond: "For development and applications of crystal devices to highly precise frequency control, and temperature and pressure instrumentation."

1972 - W.J. Spencer: "For advances in the theory and development of piezoelectric crystal devices."

1973 - James C. King: "For major contributions to the understanding of the fundamental properties of quartz crystals, and methods for improvement of these properties in synthetic quartz."

1974 - Robert A. Laudise, Robert A. Ballman and David W. Rudd: "For outstanding contributions to the synthesis of crystalline quartz with special properties for resonator applications."

1975 - Morio Onoe: "For theoretical and practical contributions in the field of frequency control and selection, as well as leadership in national and international committees on piezoelectric devices."

1976 - Warren L. Smith: "For outstanding contributions in the field of precision crystal controlled oscillators of high spectral purity and monolithic crystal filters."

1977 - Virgil E. Bottom: "In recognition of theoretical and practical contributions to the Quartz Crystal Industry, and inspiration to his students to choose this field of endeavor."

1978 - Arthur D. Ballato: "For contributions in the field of piezoelectric crystals such as; stacked filters, electric circuit analogues and stress effects in doubly rotated plates."

1979 - Harry F.R. Tiersten: "For contributions to the theory of piezoelectric resonators."

1980 - Peter Chung-Yi Lee: "For contributions to the theory of vibrations in quartz crystal plates."

1981 - Eduard A. Gerber: "For pioneering research in VHF and UHF precision oscillators and filter crystals and international leadership in the field of frequency control" and Roger A. Sykes: "For outstanding contributions in the development and application of quartz crystals in the frequency control industry."

1982 - No award given in this year (due to lack of suitable award nominations).

AWARD WINNERS, 1983 to 1988:

Year	Cady Award	Rabi Award	Sawyer Award
1983	Errol P. EerNisse "For his theoretical prediction of planar stress compensation in doubly rotated quartz plate resonators leading to the realization of the SC-cut."	I.I. Rabi "For theoretical and experimental contributions to atomic beam resonance spectroscopy leading to the development of practical atomic frequency standards."	Erich Hafner "For technical contributions and leadership in the fields of quartz resonator research, technology and measurement, and high precision frequency control."
1984	Arthur W. Warner "For his contributions to the development of high precision quartz crystal units."	David W. Allan "For his contributions to the statistics of atomic clocks, measurement techniques, time scale and time coordination and distribution."	William B. Benedick, Robert A. Graham and Frank W. Neilson "For their fundamental experimental studies of the physical properties of crystalline quartz under extreme pressures and rates of loading leading to applications including a high pressure quartz stress gauge with nanosecond time resolution."
1985	John A. Kusters "For his contributions to the development of SC-cut and other doubly rotated quartz resonators."	Norman Ramsey "For his contributions to the development of atomic frequency standards."	Thrygve Meeker "For his contributions to the theory and design of piezoelectric quartz devices."
1986	Juergen H. Staudte "For his pioneering contributions to the photolithographic processing of quartz devices, especially the development and commercialization of quartz tuning forks for timekeeping."	Jerrold R. Zacharias "For his contributions to the development of atomic frequency standards, especially his scientific leadership, pioneering demonstration of the technology, and entrepreneurial initiative which led to the commercialization of atomic standards."	Larry E. Halliburton "For his contributions toward the characterization of cultured quartz using infrared absorption, electron spin resonance, acoustic loss, and thermoluminescence measurements."
1987	Virgil E. Bottom "For contributions to fundamental theory and experiments, stimulation of growth of the industry, and education in quartz resonator technology."	Louis Essen "For contributions to cesium atomic beam and quartz frequency standards."	John A. Kusters "In recognition of outstanding contributions in engineering, technology development and management relating to quartz crystals and devices."

Year	Cady Award	Rabi Award	Sawyer Award
1988	Baldwin Sawyer "For his work leading to the development of improved cultured quartz crystals, improved qualification techniques, and his tireless contributions to the frequency control industry."	Gernot M.R. Winkler "For early development of worldwide clock synchronization through use of portable clocks; encouragement and support for the development of atomic frequency standards from their earliest days; and international leadership in the time and frequency community."	Charles A. Adams "For contributions to the development of unique devices and manufacturing technology."

INDEX TO THE PROCEEDINGS OF THE FREQUENCY CONTROL SYMPOSIUM 1956 (10TH) TO 1988 (42ND)

Prepared by: John R. Vig, US Army Electronics Technology and Devices Laboratory (LABCOM)

This index consists of a subject index and an author index. Each paper has been assigned to one of fourteen categories. The subject categories are as follows:

1. Fundamental Properties of Natural and Synthetic Piezoelectric Crystals
2. Theory and Design of Piezoelectric Resonators
3. Radiation Effects on Resonators and Oscillators
4. Resonator Processing Techniques and Aging
5. Filters, Surface and Shallow Bulk Acoustic Wave Devices, Other Nonquantum-electronic Microwave Resonators, and Non-Piezoelectric Acoustic Resonators
6. Quartz Crystal Oscillators and Frequency Control Circuitry
7. Quantum Electronic Frequency Standards (Microwave Frequencies)
8. Quantum Electronic Frequency Standards (Visible and Infrared Frequencies)
9. Frequency and Time Coordination and Distribution
10. Applications of Frequency Control Devices
11. Measurements and Specifications
12. Frequency Stability and Phase Noise (other than "measurement of")
13. Sensors and Transducers
14. Other Topics

The papers are listed first according to the subject categories. Within each subject category, the papers are listed in the order of the Proceedings volume numbers, then under each Proceedings volume, according to the page numbers. (There were no Proceedings published prior to the 10th Symposium.)

The papers are numbered according to the following numbering system:

first number = subject category
second number = symposium number
third number = page number of the first page of the paper

For example, paper number 11-24-301 is listed under category 11- Measurements and Specifications, it is in the Proceedings of the 24th Symposium, and the paper starts on page 301 of that Proceedings volume.

Users of this index are cautioned that each paper is assigned to only one subject category, even though most papers touch on more than one category.

In the author index, the names of the authors are listed alphabetically, and for each author, the papers are listed chronologically according to the Proceedings volume number.

This index is intended to be revised and updated periodically. Please send comments and corrections to:

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Thanks are due to Karen Blisnuk, Raymond L. Filler, Joanna Pridy and Deborah Semasko for their contributions to the preparation of this document.

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1-41-228 Transmission X-Ray Topography of Single Crystal Quartz Using White Beam Synchrotron Radiation - W.P. Hanson

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2-10-1 The Piezoelectric Survey of Strain Patterns in Thickness Shear Quartz Resonators - K.S. Van Dyke

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2-10-46 Frequency Temperature Behavior of AT-Cut Quartz Resonators - A.R. Chi

2-10-182 Some Phenomena in VHF Crystal Units - E. Hafner

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2-21-28 On the Sinusoidal Steady-State Characteristics of Multielectroded Piezoelectric Devices - E.P. EerNisse and R. Holland

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2-27-1 Elastic Waves and Vibrations in Deformed Crystal Plates - P.C.Y. Lee, Y.S. Wang and X. Markenscoff

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2-29-10 Higher-Order Temperature Coefficients of Frequency of Mass-Loaded Piezoelectric Crystal Plates - A.D. Ballato and T.J. Lukaszek

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2-29-76 Vibrational Response of a Sonar Transducer Using Piezoelectric Finite Elements - J.T. Hunt

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2-30-1 Effects of Acceleration on the Resonance Frequencies of Crystal Plates - P.C.Y. Lee and K.M. Wu

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2-34-403 Nonlinear Effect of Initial Stresses in Doubly-Rotated Crystal Resonator Plates - P.C.Y. Lee and K.M. Wu

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2-37-343 Miniaturized $LiTaO_3$ Strip Resonator - Y. Fujiwara, S. Yamada and N. Wakatsuki

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2-38-141 Analysis and Design of Coupled Mode AT Rectangular Resonators - J. Tomase and L.N. Dworsky

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2-38-176 On the Change in Orientation of the Zero-Temperature Contoured SC-Cut Quartz Resonator with the Radius of the Contour - D.S. Stevens and H.F. Tiersten

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2-38-245 Extended Pressure and Temperature Operation of BT-Cut Pressure Transducers - G.S. Kaitz

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2-39-372 Highly Stable, Ovenized Bulk Shear Mode Resonators - B.R. McAvoy, S.V. Krishnaswamy, H.L. Salvo, Jr. and R.A. Moore

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2-39-381 Characteristics of a Quartz Crystal Tuning Fork with Shortened Arm Length for High Frequencies - M. Okazaki, H. Tohma and Y. Tomikawa

2-39-386 Analysis of Trapped Energy Resonators with Tabs - H. Sekimoto, H. Nakata and M. Miura

2-39-392 A Variational Method for the Design of Trapped Energy Resonators - R.C. Peach

2-39-400 Further Results on the Contour Dependence of the Frequency-Temperature Characteristic of SC-Cut Resonators - J.A. Kosinski

2-39-405 Mechanical Couplings Involving Discontinuities of the Frequency-Temperature Curves of Contoured Quartz Resonators - R. Bourquin, B. Dulmet and G. Genestler

2-39-415 Frequency-Temperature Behavior of Flexural and Thickness-Shear Vibrations of Rectangular Rotated Y-Cut Quartz Plates - Y.K. Yong and P.C.Y. Lee

2-39-427 A note on "Ballato's Angle Increment" - J.H. Sherman, Jr.

2-39-431 Vibrations of Piezoelectric Discs Under Initial Stresses - M.C. Dokmeci

2-39-436 An Analysis of Doubly-Rotated Contoured Quartz Crystal Resonators - D.S. Stevens and H.F. Tiersten

2-39-448 Generalized Equation for the Force-Frequency Characteristics of Circular Quartz Plates with Three-Point Support and its Application to Supporting of an SC-Cut Plate - N. Oura, N. Kuramochi, Y. Miyazaki, M. Yamashina and S. Suzuki

2-39-453 Vibrations of Doubly-Rotated Piezoelectric Crystal Strip with a Pair of Electrode-Plated, Traction-Free Edges - P.C.Y. Lee and J.P. Hou

2-39-462 Simple Thickness Plate Modes Driven by Lateral Fields - A.D. Ballato, E.R. Hatch, M. Mizan, T.J. Lukaszek and R. Tilton

2-39-473 Lateral Field Resonators - A.W. Warner, Jr. and B. Goldfrank

2-40-145 Dynamic Permittivities and Resistivities of the Equivalent Network Representing Plate Resonators - A.D. Ballato, E.R. Hatch, M. Mizan and T.J. Lukaszek

2-40-152 Initial Stress Field and Resonance Frequencies of Incremental Vibrations in Crystal Resonators by Finite Element Method - P.C.Y. Lee and M.S.H. Tang

2-40-161 A Transmission Line Matric Model for AT Quartz Thickness Shear Devices - L.N. Dworsky

2-40-168 Nonlinear Electroelastic Equations of Wave Propagation and Vibrations in Quartz Bars - M.C. Dokmeci

2-40-179 Three-Dimensional Finite Element Solution of the Lagrangean Equations for the Frequency-Temperature Behavior of Y-Cut and NT-Cut Bars - Y.K. Yong

2-40-187 Suppression of Anharmonic Spurious Modes by Modified Electrode Design Using Charge Cancellation - H. Sekimoto, T. Ihara, H. Nakata and M. Miura

2-40-193 Variational Analysis of GT-Cut Quartz Crystal Resonators with the Supporting Portions at the Ends - H. Kawashima

2-40-201 An Overtone-Mode Assigned AT-Cut Crystal Resonator - K. Hirama, T. Shoji and Y. Tanaka

2-40-206 Overtone Response of Composite Bulk Acoustic Resonators - J. Rosenbaum, H.L. Salvo, Jr. and S.V. Krishnaswamy

2-40-262 An Analysis of the Acceleration Sensitivity of ST-Cut Quartz Surface Wave Resonators Supported Along the Edges - D.V. Shick and H.F. Tiersten

2-40-269 Low Loss, Highly Stable Saw Devices on Quartz - T.N. Oliver, D.E. Bower and J. Dowsett

2-40-285 Acoustic Charge Transport Principles and Performance - M.J. Hoskins, M.J. Brophy, J.M. Dallesasse, M.J. Miller and J.W. Peterson

2-41-236 Studies of Quartz Resonators by Stroboscopic Topography - A. Zarka, B. Capelle, J. Detaint and J. Schwartzel

2-41-266 Nonlinear Constants and Their Significance - J.J. Gagnepain

CATEGORY 3:

Radiation Effects on Resonators and Oscillators

3-12-101 Pile Irradiation of Quartz Crystal Units - F.E. Graham and A.F. Donovan

3-13-37 Defects of the Quartz System Produced by Neutron Irradiation - R. Weeks

3-14-138 Nuclear Radiation Effects in Quartz Crystals - J.M. Stanley

3-16-7 Effects of Reactor Irradiation on Thickness Shear Crystal Resonator - J.C. King and D.B. Fraser

3-17-127 Aging Characteristics of Quartz Resonators with Comments on the Effects of Radiation - R.B. Belser and W.H. Hicklin

3-20-82 Radiation Effects in Frequency Control Devices - J.M. Stanley

3-23-178 Effects of Gamma Irradiation on Frequency Stability of 5th Overtone Crystal Oscillators - C.A. Berg and J.R. Erickson

3-27-113 Rapid Annealing of Frequency Change in High Frequency Crystal Resonators Following Pulsed X-Irradiation at Room Temperature - J.C. King and H.H. Sander

3-27-120 Crystal Controlled Oscillators for Radiation Environments - R.E. Paradysz and W.L. Smith

3-27-124 Calculation of Transient Thermal Imbalance Within Crystal Units Following Exposure to Pulse Irradiation - E.F. Hartman and J.C. King

3-27-128 Transient X-Ray Induced Conductivity in Single Crystal Quartz - R.C. Hughes

3-27-136 Hydrogen Diffusion in Quartz: The Kinetics of a One-Dimensional Process - A. Sosin

3-27-139 Effects of a Co-60 Gamma-Ray Irradiation on the Optical Properties of Natural and Synthetic Quartz from 85 to 300 K. - P.L. Mattern, K. Lengweiller and P.W. Levy

3-27-153 A Review of Impurity Atom Defects in -Quartz as Observed by Electron Paramagnetic Resonance - J.A. Weill

3-28-143 The Effect of Gamma Irradiation on the Temperature-Frequency Characteristic of AT-Cut Quartz - H.J. Benedikter, J.H. Sherman, Jr. and R.D. Gillespie III

3-33-62 Radiation Effects in Berlinite - L.E. Halliburton, L.A. Kappers, A.F. Armington and J.J. Larkin

3-33-98 Point Defects and Radiation Damage Processes in a-Quartz - D.L. Griscom

3-33-118 Radiation-Induced Frequency Transients In AT, BT and SC-Cut Quartz Resonators - D.R. Koehler

3-33-122 Radiation Effects in Swept Premium-Q Quartz Material, Resonators and Oscillators - H.G. Lipson, F.K. Euler and P.A. Ligor

3-33-134 Radiation-Induced Mobility of Interstitial Ions in Synthetic Quartz - J.J. Martin, S.P. Doherty, L.E. Halliburton, M.E. Markes, N. Koumvakalis, W.A. Sibley, R.N. Brown and A.F. Armington

3-34-72 Radiation Effects in Quartz Oscillators, Resonators and Materials - F.K. Euler, H.G. Lipson and P.A. Ligor

3-35-322 Radiation-Induced Conductivity and High Temperature Q Changes in Quartz Resonators - D.R. Koehler

3-37-130 Radiation Induced Transient Acoustic Loss in Quartz Crystals - D.R. Koehler and J.J. Martin

3-38-32 Effect of Irradiation and Annealing on the Electrical Conductivity of Quartz Crystals - E.R. Green, J. Toulouse, J. Wacks and A.S. Nowick

3-38-55 An X-Ray Irradiation System for Total-Dose Testing of Quartz Resonators - L.J. Palkuti and Q.T. Troung

3-38-63 Results from Gamma Ray and Proton Beam Radiation Testing of Quartz Resonators - J.R. Norton, J.M. Cloeren and J.J. Suter

3-39-259 Radiation Effects in Quartz: Low Doses and Defect Production Mechanisms - L.E. Halliburton, C.Y. Chen and S.D. Tapp

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3-40-96 Study of Irradiation Effects in Quartz Crystal Using Low-Temperature Dielectric Relaxation - S. Ling and A.S. Nowick

3-40-127	Evaluation of Mechanisms for Low-Dose Frequency Shifts in Crystal Oscillators - T.M. Flanagan, R.E. Leadon and D.L. Shannon
3-40-134	Low and Medium Dose Radiation Sensitivity of Quartz Crystal Resonators with Different AL-Impurity Content - J.J. Suter and R.H. Maurer
3-41-216	Radiation Effects in Vacuum-Swept Quartz - A. Kahan, F.K. Euler, H.G. Lipson, C.Y. Chen and L.E. Halliburton

CATEGORY 4:

Resonator Processing Techniques and Aging

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4-10-190 Crystal Unit Design for Use in a Ground Station Frequency Standard - A.W. Warner, Jr.

4-10-513 Tests on Hermetic Enclosures of Piezoelectric Quartz Crystals - B.W. Schumacher

4-10-524 Production Procedures for VHF Crystals - R.D. Cortwright

4-10-540 Manufacturing Problems Connected with High Precision Crystals - J.M. Wolfskill

4-10-569 Manufacturing Problems Connected with Miniaturized Crystals - G.K. Bistline, Jr.

4-10-573 Automatic X-Ray Sorter for Crystal Blanks - L.V. Wise

4-11-157 Aging Study of Quartz Resonators - R.B. Belser and W.H. Hicklin

4-11-189 High Temperature AT-Cut Crystal Units - C.W. Mann

4-11-214 High Temperature, Low Frequency Crystal Units - J.M. Wolfskill

4-11-240 High Precison Crystal Units - L.A. Dick

4-11-256 Stability of Quartz Resonators at Very Low Temperatures - F.P. Phelps

4-11-277 Fundamental Studies on an Improved Crystal-Controlled Frequency Standard - M.D. Fagen and W.L. Smith

4-12-37 Effects of Plating to Frequency on the Stability of Quartz Resonators - R.B. Belser and W.H. Hicklin

4-12-162 Research at NBS Boulder Laboratories on Quartz Crystal Resonators and Oscillators at Low Temperatures - F.P. Phelps and A.H. Morgan

4-12-211 Ruggedization of Low Frequency Crystal Units - J.M. Wolfskill

4-12-241 Phase Stable Quartz Crystal Units - L.A. Dick

4-12-260 Moderate Precision Crystal Units - D.L. Hammond

4-12-281 Low Frequency XY'Flexure Crystal Units - A.S. Matistic

4-12-296 Design Data for HF AT Crystal Units - L.A. Tyler and C. Rutkowski

4-12-316 Design Parameters for VHF Crystal Units - D. McKeown

4-13-71 Aging Studies on Crystal Units - R.B. Belser and W.H. Hicklin

4-13-109 Aging Characteristics of Quartz Crystal Units - P.E. Mulvihill

4-13-406 Phase Stable Crystal Units - L.A. Dick

4-13-423 Glass Enclosed Moderate Precision Crystral Units - E.M. Shideler and D.L. Hammond

4-13-430 Glass Enclosed Minaturized Crystal Units - H. Long

4-13-445 High Temperature Crystal Units Employing Thermocompression Techniques - J.P. Griffin

4-13-498 Development and Production of Glass Enclosed Quartz Crystals - R.S. Sennett, D.M. Eisen and L.R. Clark

4-13-512 Fabrication of High Precision 5 Mc Crystal Units - J.M. Wolfskill and R.T. Schlaudecker

4-13-529 Results of Pilot Runs in a Mechanized Crystal Plant - A. Mann

4-13-535 Production of VHF Crystal Units - G.F. Fisher

4-14-68 Parallel Field Excitation of Thickness Modes of Quartz Plates - R. Bechmann

4-14-115 The Aging of Aluminum Plated 16.5 Mc AT-cut Quartz Resonators - R.B. Belser and W.H. Hicklin

4-14-154 Development of Precision Crystal Units for Satellite Use - J.M. Wolfskill and R.T. Schlaudecker

4-14-397 Tuning Forks as Circuit Elements - M. Pleasure

4-15-49 Temperature Compensation of Piezoelectric Resonators by Mechanical Stress - E.A. Gerber and M.H. Miles

4-15-66 Stability Studies of Quartz Crystals for Satellites - R.B. Belser and W.H. Hicklin

4-15-109 Micro-Module and Ultra-Miniaturized Crystal Units - R.R. Bigler

4-15-113 Precision Glass Enclosed Crystal Units - E.M. Shideler and P.E. Bryan

4-15-125 Precision Quartz Resonators - D.L. Hammond

4-16-110 Aging of Quartz Resonators at Fundamental and Overtone Modes with Comments on Radiation Effects - R.B. Belser and W.H. Hicklin

4-16-146 Recent Developments in Miniaturized Glass Enclosed Crystal Holders - G.K. Bistline, Jr.

4-16-156 Improved Ceramic Envelopes for Micromodule Crystal Units - J.H. Sherman, Jr.

4-16-169 Temperature Compensated Quartz Crystal Units - R.J. Munn

4-17-4 Studies on High Precision Resonators - R.A. Sykes, W.L. Smith and W.J. Spencer

4-17-215 Precision Crystal Units - D.L. Hammond, C.A. Adams and L.S. Cutler

4-17-233 High Q Crystal Units - W. Ianouchevsky

4-17-248 Use of Parallel-Field Excitation in the Design of Quartz Crystal Units - A.W. Warner, Jr.

4-17-267 Crystal Units for Single Sideband Application - P.E. Bryan and E.M. Shideler

4-17-272 Design Equations for Plano-Convex AT-Filter Crystals - W.G. Stoddard

4-17-283 Development Status of Quartz Micromodule Crystal Units - P.J. Staelens

4-17-302 Improvements in Technique for Thermo-Compressing Mounting Wires to Quartz Crystal Plates - J.P. Griffin

4-17-325 Problems Associated with Precision Quartz Resonators - W.J. Spencer

4-18-129 Aging Analysis of AT-Cut Quartz Resonators of Natural, Cultured and Swept Varieties - R.B. Belser and W.H. Hicklin

4-18-166 Design and Performance of a New Series of Cold Welded Crystal Unit Enclosures - R.J. Byrne and R.L. Reynolds

4-18-181 A New Design for Microminiature Crystals - W.G. Stoddard

4-18-193 Glass Enclosed Crystal Units for Temperature Compensated Oscillators - G.K. Bistline, Jr. and D.B. Jacoby

4-18-204 New Developments in Glass Enclosed Crystal Units - D.M. Eisen

4-18-217 Reliability of Quartz Crystal Units - J.M. Stanley and P.E. Mulvihill

4-18-426 On the Control of the Temperature Coefficient of Frequency of AT-Crystals - C. Franx

4-18-597 High-Q, BT-Cut, Quartz Resonator Units - A. Seed

4-19-78 Miniature Single Sideband Crystal Units - J.M. Wolfskill and R.A. Spurlin

4-19-105 Passive Temperature Compensation of Quartz Crystals for Oscillator Applications - S.B. Boor, W.H. Horton and R.B. Angove

4-19-125 Seal Test Methods and Evaluation of Enclosures for Crystal Units - R.L. Reynolds and R.J. Byrne

4-19-137 Application of Leak Theory to Crystal Testing - J.W. Marr and J.H. Sherman, Jr.

4-20-161 Comments on Unwanted Responses in VHF Crystals - E.A. Gerber

4-20-167 Discussion of 3.0 and 5.0 MHz, SSB Crystals Precise and Uniform - R.F. Woolley and G.A. Lagasse

4-20-180 Aging of Aluminum Plated 3-MC Semi-Precision Resonators - R.B. Belser and W.H. Hicklin

4-20-192 Aging Characteristics of Quartz Crystal Resonators - J.H. Armstrong, P.R. Blomster and J.L. Hokanson

4-20-208 Quartz Crystal Life Test Data - F. Wolf and G.K. Bistline, Jr.

4-20-219 Five Megacycle Fifth Overtone Resonators Operating Near the Inflection Temperature - J.G. Leach

4-20-234 Microminiature Cold Weld Crystal Units - A. Seed

4-20-530 Low Power Crystal Ovens - M.B. Bloch, J. Ho and I. Math

4-21-200 The Transient Thermal Characteristics of Quartz Resonators and Their Pelation to Temperature-Frequency Curve Distortion - L.E. Schnurr

4-21-211 AT-Cut Resonators with Annular Electrodes - R.B. Belser and W.H. Hicklin

4-21-224 SSB Quartz Crystal Units Utilizing Coldweld Enclosures and High Temperature Bakeout Techniques - F.R. Brandt and G.E. Ritter

4-21-244 Increased Crystal Units Resistance at Oscillator Noise Levels - M. Bernstein

4-22-67 Design Considerations for Oscillator Crystals - G.K. Guttwein, A.D. Ballato and T.J. Lukaszek

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4-22-89 Advancements in Production of 5-MHz Fifth Overtone High Precision Crystal Units - J.M. Wolfskill

4-22-118 Kold-Seal Thermal Compression Bonded Crystals - J. Denman, G.A. Lagasse, M.B. Bloch and J. Ho

4-22-136 Quartz Crystal Aging - E. Hafner and R.S. Blewer

4-22-155 Improvements in Sealing HC-26/U and HC-27/U Glass Holders - G. Giber[illegible]

4-22-226 Micro Resonators in [illegible] Electronics - J.H. Staudte

4-23-132 Comparison of Aging Performance of 5-MHz Resonators Plated with Various Electrode Metals - R.B. Belser and W.H. Hicklin

4-23-163 Laser Machining Thin Film Electrode Arrays on Quartz Crystal Substrates - J.L. Hokanson

4-24-111 Auger Spectroscopy in Studies of the Aging Factors of Quartz Crystal Resonators - G.W. Simmons, W.H. Hicklin and R.K. Hart

4-24-117 5 MHz BT Cut Resonators - J.G. Leach

4-24-126 Mode Control and Related Studies of VHF Quartz Filter Crystal - T.J. Lukaszek

4-24-141 Low Aging Crystal Units for Use in Temperature Compensated Oscillators - J.F. Silver and L.A. Dick

4-24-148 Dynamic Temperature Behavior of Quartz Crystal Units - W.H. Hicklin

4-24-157 The Direct Temperature Control of Quartz Crystals in Evacuated Enclosures - F.G. Tinta, A.S. Matistic and G.A. Lagasse

4-26-71 Thermocompression Bonding to Quartz Crystals - R.J. Byrne

4-26-78 Modern Technologies - F. Ura

4-26-120 Frequency Control Devices for High Stability Remote Sensor Transmitters - J.M. Stanley, H. Wasshausen and S. Schodowski

4-26-152 Precision and SSB Crystal Units for Temperature Compensated Crystal Oscillators - R.K. Hart and W.H. Hicklin

4-27-42 Low Frequency Resonators of Lithium Tantalate - M. Onoe, T. Shinada, K. Itch and S. Miyazaki

4-27-50 Subminiature Quartz Tuning Fork Resonators - J. Staudte

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4-27-79 Clean Surface Technology - M.L. White

4-27-89 Thin Film Metallization of Oxides - D.M. Mattox

4-27-98 Surface Preparation and Characterization Techniques for Quartz Resonators - J.R. Vig, H. Wasshausen, C.F. Cook, Jr., M. Katz and E. Hafner

4-28-85 The Structure and Properties of Thin Metal Films - D.M. Hoffman

4-28-89 Methods of Cleaning Contaminants from Quartz Surfaces During Resonator Fabrication - R.K. Hart, W.H. Hicklin and L.A. Phillips

4-28-96 Surface Studies for Quartz Resonators - J.R. Vig, C.F. Cook, Jr., K. Schwidtal, J.W. LeBus and E. Hafner

4-28-109 Stabilization of Resonance Frequencies in Piezoelectric Ceramic Resonators Against Sudden Temperature Change - M. Takahashi, F. Yamauchi and S. Takahashi

4-29-128 A Survey of Ion Beam Milling Techniques for Piezoelectric Device Fabrication - R.N. Castellano and J.L. Hokanson

4-29-187 32 KHz Quartz Crystal Unit for High Precision Wrist Watch - J. Engdahl and H. Matthey

4-29-202 A New Ceramic Flat Pack for Quartz Resonators - P.D. Wilcox, G.S. Snow, E. Hafner and J.R. Vig

4-29-220 Further Results on UV Cleaning and Ni Electrobonding - J.R. Vig, J.W. LeBus and R.L. Filler

4-29-230 On the Origin of the 'Second Level of Drive' Effect in Quartz Oscillators - J.E. Knowles

4-29-240 A High Precision Laser Assisted X-Ray Goniometer for Circular Plates - J.R. Vig

4-30-23 Fracture Resistance of Synthetic α - Quartz Seed Plates - D.L. Brownlow

4-30-78 A New Piezoelectric Resonator Design - R.J. Besson

4-30-209 Direct Plating to Frequency - A Powerful Method for Crystals with Closely Controlled Parameters - R. Fischer and L. Schulzke

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4-30-232 Design of a Nozzle Beam Type Metal Vapor Source - R.P. Andres

4-30-237 An Evaluation of Leak Test Methods for Hermetically Sealed Devices - R.E. McCullough

4-30-240 Characterization of Metal-Oxide System by High Resolution Electron Spectroscopy - E.J. Scheibner and W.H. Hicklin

4-30-249 A Novel Method of Adjusting the Frequency of Aluminum Plated Quartz Crystal Resonators - V.E. Bottom

4-30-254 Polishing Layer of Crystal Plates - H. Fukuyo and N. Oura

4-30-259 A Method of Angle Correction - D. Husgen and C.C. Calmes

4-30-264 The Effect of Bonding on the Frequency vs. Temperature Characteristics of AT-Cut Resonators - R.L. Filler and J.R. Vig

4-31-122 Accoustic Bulk Wave Resonators and Filters Operating in the Fundamental Mode at Frequencies Greater than 100 MHz - M. Berte

4-31-126 The Relationship Between Quartz Surface Morphology and the Q of High Frequency Resonators - R.N. Castellano, T.R. Meeker and R.C. Sundahl

4-31-131 Chemically Polished Quartz - J.R. Vig, J.W. LeBus and R.L. Filler

4-31-144 Aging Analysis of Quartz Crystal Units with Ti Pd Au Electrodes - G.L. Dybwad

4-31-153 Making Doubly Rotated Quartz Plates - W.L. Bond and J.A. Kusters

4-32-282 Design and Implementation of an Etch System for Production Use - D. Ang

4-32-286 Simplified Fixtures with Improved Thin Film Deposition Uniformity on Quartz Crystals - G.L. Dybwad

4-32-290 Polyimide Bonded Resonators - R.L. Filler, J.M. Frank, R.D. Peters and J.R. Vig

4-32-304 Final X-Ray Control of the Orientation of Round or Rectangular Quartz Slides for Industrial Purposes - J.F. Darces and H. Merigoux

4-32-310 Goniometric Measurements of the Angles of Cut of Doubly Rotated Quartz Plates - J. Clastre, C. Pegeot and P.Y. Leroy

4-32-317 Fully Automated Piezogoniometer (Automatic Quartz Plate Classifier) - Y. Kobayashi

4-32-321 Basic Considerations on Metal Canned Enclosures for the Encapsulation of Quartz Crystal Units - D. Fuchs

4-33-351 Etching Studies on Singly and Doubly Rotated Quartz Plates - J.R. Vig, R.J. Brandmayr and R.L. Filler

4-33-359 Anisotropy of Etching Rate for Quartz in Ammonium Bifluoride - P. Suda, A.E. Zumsteg and W. Zingg

4-33-364 A Microprocessor Assisted Anodizing Apparatus for Frequency Adjustments - D. Ang

4-33-368 Continuous Vacuum Processing System for Quartz Crystal Resonators - R.J. Ney and E. Hafner

4-34-34 An On-Wafer Detection Method of the Imbalance of Quartz Tuning Fork Resonators - P.E. Debely and R.J. Dinger

4-34-41 A Micro-Processor Assisted Baseplating Apparatus with Improved Plateback Distribution - D. Ang

4-34-46 Analysis of Quartz Resonator Electrodes Using the Rutherford Backscattering Technique - G.L. Dybwad

4-34-112 New Method to Saw Quartz Slides - H. Merigoux, J.F. Darces and J. Lamboley

4-34-120 Highly Precise Measurement of Orientation Angle for Crystal Blanks - N. Asanuma and J. Asahara

4-34-167 Production Statisitics of SC (or TTC) Crystals - J.A. Kusters and C.A. Adams

4-34-175 Further Advances on B.V.A. Quartz Resonators - R.J. Besson and U.R. Peier

4-34-183 Further Developments on 'SC' Cut Crystals - B. Goldfrank and A.W. Warner, Jr.

4-35-40 Vacuum Processing System for Quartz Crystal Resonators - J.M. Frank

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4-35-56 X-Ray Goniometry of the Modified Doubly Rotated Cuts - E. Knolmayer

4-41-360 Parametric Failure Rate Model for Quartz Crystal Device Aging with Application to Surface Acoustic Wave Filters - A.A. Feinberg

4-41-429 Fabrication and Methods for Evaluation and Circuit Utilization of Prototype Lateral Field Resonators - M.M. Driscoll and W.P. Hanson

4-41-444 The Aging of Resonators and Oscillators Under Various Test Conditions - R.L. Filler, R. Lindenmuth, J. Messina, V.J. Rosati and J.R. Vig

4-41-548 Use of Annular SAW for Cutting Quartz Resonator Blanks and Comparison with Other Methods - J. Dowsett, R.B. Spencer and A.F.B. Wood

4-42-85 Stroboscopic X-Ray Topography of Quartz Resonators - A. Zarka, B. Capelle, Y. Zheng, M. Curie, J. Detaint and J. Schwartzel

4-42-93 Probe Examination of Thickness-Shear Vibrations of AT-Cut Narural Quartz Crystals: Some New Results - R. Parshad and A. Sharma

4-42-189 New Technology for Detection and Removal of Surface Contamination Involving Particulates or Water/Organic Materials (Invited Paper) - S. Hoenig

4-42-202 Measurement of Plano-Convex SC Quartz Blanks Using Lateral Field Excitation - A.W. Warner, Jr.

4-42-205 Use of Annular SAW for the Cutting of Quartz Resonator Blanks and Substrates - J. Dowsett, R.B. Spencer and P.E. Morley

4-42-208 X-Ray Topographic Study of Vacuum Swept Quartz Crystals - A. Zarka, M. Sebastian and B. Capelle

4-42-211 A New Shutter System for Fine-Tuning Coupled-Dual Crystals - G. Roberts

4-42-404 Aging Prediction of Quartz Crystal Units - M. Miljkovic, G. Trifunovic and V. Brajovic

4-42-412 Experimental Results of Aging of AT-Cut Strip Resonators - J. Gehrke and R. Klawitter

CATEGORY 5:

Filters, Surface and Shallow Bulk Acoustic Wave Devices, Other Nonquantum-electronic Microwave Resonators, and Non-Piezoelectric Acoustic Resonators

5-10-339 High-Frequency Crystal Filters - D.I. Kosowsky

5-11-535 Latest Developments in Mechanical Filters - J.C. Hathaway

5-11-556 High-Frequency Crystal Filters - L. Storch

5-12-437 Filter Crystals - R. Bechmann

5-12-475 High Frequency Crystal Filters - R.A. Sykes

5-12-501 Type NB Bandpass Crystal Filters - L. Storch

5-13-404 Single-Side-Band Crystal Filters - M. Dishal

5-13-405 Quartz Crystal Mechanical Filters - H. Yoda

5-14-361 VHF Crystal Filters - F.K. Priebe and D. Schwab

5-15-318 Transfer Function Synthesis of Quartz Crystal Filters - E.C. Ho

5-16-347 HF and VHF Crystal Filters - S. Malinowski and D. Schennberg

5-16-373 High Frequency Crystal Electromechanical Filters - Y. Nakazawa

5-17-566 Recent Developments in Crystal Filters - D.I. Kosowsky and C. Hurtig

5-18-536 The Synthesis of Crystal-Capacitor Tandem Lattice All-Pole Bandpass Filters on the Insertion-Loss Basis - R.C. Smythe

5-18-558 Crystal Filter Techniques - S. Malinowski

5-19-42 Ultrasonic Tapped Delay Lines for Filter Applications - G.A. Coquin

5-19-213 Factors in the Design of VHF Filter Crystals - D.R. Curran and D.J. Koneval

5-19-269 Improvements of Quartz Filter Crystals - T.J. Lukaszek

5-19-509 Design of SSB and VHF Crystal Filters - E.C. Ho and R.H. Tuznik

5-19-534 Trapped Energy Modes, Network Synthesis, and the Design of Quartz Filters - A.D. Waren, W.J. Gerber and D.R. Curran

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5-42-252 SAW Tapped Delay Lines for New Potential Circuit Applications - W.J. Skudera, Jr.

5-42-259 Dielectric Resonators (Invited Paper) - P. Guillon

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5-42-284 Temperature Compensation of SAW Oscillators - M. Cracknell, A. Harrison and D. Sharpe

5-42-288 Frequency Stability of SAW Oscillators at High Temperatures - B.K. Sinha, Y. Sudo, S. Sato and J. Groves

5-42-301 Theory and Design of Low Phase Noise Microwave Oscillators - R. Rogers

5-42-364 A Phase-Locked 4-6 GHz Local Oscillator Using Microwave Prescaler - P. Kandpal

5-42-369 Low Noise, Microwave Signal Generation Using Bulk and Surface Acoustic Wave Resonators - M.M. Driscoll

5-42-378 Low Phase Noise Oscillators Above 1 GHz Utilizing Hermetically Sealed All Quartz Resonators and Harmonic Extraction - C. Chase, R. Laton and C. Yuen

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Quartz Crystal Oscillators and Frequency Control Circuitry

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6-10-268 The Evaluation of Phase-Stable Oscillators for Coherent Communication System - W.K. Victor

6-10-354 Design Data for Crystal Oscillators - H.E. Gruen

6-10-422 A Precision Crystal Oven - M.D. McFarlane and R.B. Metz

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6-12-406 A Precision Delayed Pulse Generator as a Variable Time Interval Standard - D. Hartke, M. Willrodt and D. Broderick

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6-13-182 Designing Transistor Oscillator for Crystals - J.H. Sherman, Jr.

6-13-191 Highly Stable Crystal Oscillators for Missile Application - A.W. Warner, Jr. and W.L. Smith

6-13-232 Missile-borne Frequency Standard - H.P. Brower

6-13-350 Parametric Frequency Multiplication for Atomic Frequency Standards - R. Rafuse

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6-13-566 A Compact Frequency Translator for Use with the Ammonia MASER - W.K. Saunders

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6-15-282 Design of Low Power Crystal Oven - I.A. Black, A. Everest and T.P. Heuchling

6-15-297 A Temperature-Compensated Frequency Standard - G.R. Hykes and D.E. Newell

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6-16-405 Precision Quartz Crystal Controlled Oscillator for Severe Environmental Conditions - W.J. Spencer and W.L. Smith

6-16-422 Thermoelectric Temperature Control - T.D. Merritts and J.C. Taylor

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6-17-491 Temperature Compensation of Quartz Crystal Oscillators - D.E. Newell and R.H. Bangert

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6-17-587 Frequency Synthesizing Techniques Permitting Direct Control and Rapid Switching - R.R. Stone, Jr. and H.F. Hastings

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6-20-464 Microminiaturization of Time and Frequency Control Equipments - F. Van Steen and R. Troell

6-20-500 Military Synthesizer Design, Analog and Digital - R.M. Aughey and A. Seipel

6-20-501 Spurious Oscillation in Crystal Oscillators - M.E. Frerking

6-20-517 Generation of Selectable Precise Fractional Frequency Offsets - B. Parzen

6-20-544 Programmed Oscillators for Doppler Radar Systems - G.D. Thompson, Jr. and R.L. Sydnor

6-20-624 Sidereal Time Standard at the National Radio Astronomy Observatory - C.C. Bare and D.L. Thacker

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6-21-308 RADA Frequency Synthesizer - R.J. Breiding and C. Vammen

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6-22-354 The LOH Frequency Synthesizer - R.J. Hughes and R.J. Sacha

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6-26-43 Two Stage Self Limiting Series Mode Type Quartz Crystal Oscillator Exhibiting Improved Short-Term Frequency Stability - M.M. Driscoll

6-26-50 Low Noise Frequency Multiplication - R.A. Baugh

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6-26-132 A Temperature Compensated Crystal Oscillator Utilizing Three Crystals - K. Hirama and M. Onoe

6-26-140 Low Power Crystal Oscillator for Electronic Wrist Watch - H. Yoda, H. Ikeda and Y. Yamabe

6-26-264 The Disciplined Time/Frequency Standard: A New Multi-Function Crystal Oscillator - D. Babitch, J. Ho and M.B. Bloch

6-26-279 Quasiperiodic Frequency Synthesis - G. Becker

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6-27-170 Low Noise UHF Crystal Controlled Source - D.J. Healey III

6-27-180 A 500 MHz Low Noise General Purpose Frequency Synthesizer - W.F. Byers, K.W. Craft and G.H. Lohrer

6-27-191 Digitally Compensated TCXO - G.E. Buroker and M.E. Frerking

6-27-199 A Fast Warmup Quartz Crystal Oscillator - H.M. Greenhouse, R.L. McGill and D.P. Clark

6-27-218 High Stability Integrator-Controlled Oven for Crystal Oscillators - T. Hamatsuki, H. Uchida and U. Goto

6-28-181 The Design and Performance of a Crystal Oscillator Exhibiting Improved Short Term Frequency Stability - J. Groslambert, G. Marianneau, M. Olivier and J. Uebersfeld

6-28-203 Abnormal Crystal Oscillator Frequency Change with Load Capacitance and its Elimination - S. Nonaka

6-28-211 Compensated Wide Band Voltage Controlled Oscillator for the Viking Program - M.B. Bloch, M.P. Meirs and M. Rosenfeld

6-28-214 Microcircuit Temperature Compensated Crystal Oscillator (MCTCXO) - D.L. Thomann

6-28-221 New Approach to the Design of Crystal Oscillators - Y. Ohata

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6-28-237 Computer Design and Analysis for High Precision Oscillators J. Ho and R. Nardin

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6-29-294 An Analysis of Frequency Stability for TCXO - S. Fujii and H. Uchida

6-29-300 VCXO: Theory and Practice - J. Helle

6-30-275 An Ultra-Stable Low Power 5 Mhz Quartz Oscillator Qualified for Space Usage - J.R. Norton

6-30-279 Stable Oscillator for Pioneer Venus Program - M.P. Meirs, T. Robinson and M.B. Bloch

6-30-292 A Miniature High Stability TCXO Using Digital Compensation - A. Mroch and G.R. Hykes

6-30-301 Linearization of Direct FM Voltage Controlled Crystal Oscillators - S.J. Lipoff

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6-31-390 Frequency Tolerance Limitations with Logic Gate Clock Oscillators - J.D. Holmbeck

6-31-396 The MXO - Monolithic Crystal Oscillator - T. Luxmore and D.E. Newell

6-31-400 Linear Crystal Controlled FM Source for Mobile Radio Application - R. Arakelian and M.M. Driscoll

6-31-407 Design Considerations for a Digitally Temperature Compensated Crystal Oscillator - P.J. Scott

6-31-412 Precision Oscillators Flown on the LES-8/9 Spacecraft - H.S. Babbitt III

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6-32-549	Theoretical Performance of Frequency Estimators Using Phase-Locked Loops - T.A. Schonhoff
6-33-406	Performance Results of an Oscillator Using the SC Cut Crystal - R. Burgoon and R.L. Wilson
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6-33-417	An Analysis of Unwanted Frequency Oscillation in a Crystal Controlled Oscillator - S. Kodama and Y. Sato
6-33-425	A Non-Iterative Solution for a Two-Thermistor TCXO - C.T. Swanson and E.S. McVey
6-33-431	The Application of Microprocessors to Communications Equipment Design - M.E. Frerking
6-33-449	The Effect of the Sampling Action of Phase Comparators on Frequency Synthesizer Performance - M.J. Underhill and R.I.H. Scott
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6-34-213	High Speed, Broadband Tuneable Microwave Synthesizer - E.M. Perdue
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6-34-457	Performance of New Oscillators Designed for "Electrodeless" Crystals - R.J. Besson, D.A. Emmons, P.G. Girardet and E.P. Graf
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6-34-475	Miniature Packaged Crystal Oscillators - D.M. Embree, R.E. Paradysz, V.R. Saari and R.J. McClure
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6-34-498	Integrated Circuit Compensation of AT-Cut Crystal Oscillators - T. Keller, D. Marvin and R. Steele
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6-35-428 Spurious Suppression In Direct Digital Synthesizers - C.E. Wheatley III and D.E. Phillips

6-35-440 SC-Cut Quartz Crystal Units in Low-Noise Oscillator Application at VHF - D.J. Healey III and S.Y. Kwan

6-35-455 Digital Temperature Compensation of Crystal Oscillators - A.M. Renard and K. Barnhill

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6-36-492 Update on the Tactical Miniature Crystal Oscillator Program - H.W. Jackson

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6-36-562 Temperature Compensated Crystal Oscillator Panel Discussion - D.E. Newell

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6-36-576 A Temperature Compensated SC-Cut Quartz Crystal Oscillator - E.K. Miguel

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6-37-448 A New Frequency Temperature Compensation Method for Oscillators - T. Kudo, S. Fujii and S. Nanamatsu

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6-37-485 An Analysis of a Microprocessor Controlled Disciplined Frequency Standard - B. Bourke and B. Penrod

6-37-492 BVA Quartz Crystal Resonator and Oscillator Production - A Statistical Review - E.P. Graf and U.R. Peier

6-37-501 Temperature Compensated Crystal Oscillator Survey and Test Results - V.J. Rosati, S. Schodowski and R.L. Filler

6-38-86 A Vibration Compensation Scheme for a Tactical Rubidium Oscillator - W. Weidemann

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6-38-327 Balanced Feedback Oscillators - A. Benjaminson

6-38-334 Analysis and Design of the Relaxation Quartz Crystal Oscillators - D. Vasiljevic

6-38-341 GPS User Receivers and Oscillators - D. Hessick and W. Euler

6-38-363 A Time and Frequency Reference System for the Tacamo Aircraft - T.C. Jewell and J.D. Geist

6-38-366 New Approach of Fast Warm Up for Crystal Resonators and Oscillators - J.P. Valentin, M.D. Decailliot and R.J. Besson

6-38-374 Space Qualified High Performance Digitally Tuned Quartz Crystal Oscillators - R.M. Garvey, D.A. Emmons and A.F. Beaubien

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6-39-197 Low Noise, VHF Crystal-Controlled Oscillator Utilizing Dual, SC-Cut Resonators - M.M. Driscoll

6-39-202 A Satellite Oscillator for Very Precise Orbitography: The Doris Program - A. Debaisieux, J.P. Aubry, E. Gerard and M. Brunet

6-39-212 An Oscillator for the GPS Program - G. Marotel, G. Caret and J.P. Aubry

6-40-292 Fast Channelizer - A New Frequency Sorting Technique - J.H. Elliott, R.B. Stokes and K.H. Yen

6-40-325 A Frequency Adjustable Ultra-Compact, High-Performance Quartz Crystal Oscillator and Its Simple Temperature Compensation Method - O. Ochiai, F. Tamura and Y. Mashimo

6-40-329 Low Noise Crystal Oscillators Using 50-OHM, Modular Amplifier Sustaining Stages - M.M. Driscoll

6-40-340 Digital Temperature Compensation of Crystal Oscillators Using Temperature Switches - Z. Aleksic, D. Vasiljevic and A. Pavasovic

6-40-344 A Crystal Oscillator with Bidrectional Frequency Control and Feedback ALC - A. Benjaminson

6-40-350 Integrated Oven Controlled Quartz Crystal Oscillator - G. Marianneau, D. Hauden and J.J. Gagnepain

6-40-355 A Short Survey of Frequency Synthesizer Techniques - V.S. Reinhardt, K. Gould, K. McNab and M. Bustamante

6-40-366 Army Frequency Agile Synthesizer Program - A.L. Bramble and J. Kesperis

6-40-370 SOS Frequency Synthesizer Development - D.P. O'Rourke

6-40-373 Performance Analysis of the Numerically Controlled Oscillator - E.C. Kisenwether and W.C. Troxell

6-40-452 A Rubidium-Crystal Oscillator (RbXO) - W.J. Riley and J.R. Vaccaro

6-41-398 The Acceleration Sensitivity of Quartz Crystal Oscillators: A Review - R.L. Filler

6-41-409 Suppression of Vibration-Induced Phase Noise in Crystal Oscillators: An Update - V.J. Rosati

6-41-413 Crystal Oscillators for Airborne Applications - G. Caret, A. Debaisieux, E. Gerard and G. Robichon

6-41-435 A Digitally Compensated TCXO Using a Single Chip LSI - T. Hara, T. Kudo, S. Uriya, H. Saita, S. Ogou and Y. Katsuta

6-41-439 Analysis of High Performance Compensated Thermal Enclosures - F.L. Walls

6-41-452 The Design and Analysis of VHF/UHF Crystal Oscillators - A. Benjaminson

6-41-460 CMOS Gate Oscillator Design - T.B. Mills

6-41-492 Compact and Simple x 3 (9 to 27 GHz) PLL Frequency Multiplier Using Harmonic Phase Detection - J. Berenguer, J. Bara and A. Comeron

6-41-495 An Analysis of the Output Spectrum of Direct Digital Frequency Synthesizers in the Presence of Phase-Accumulator Truncation - H.T. Nicholas III and H. Samueli

6-41-512 Low Noise Frequency Synthesis - F.L. Walls and C.M. Felton

6-41-519 Low Noise Airborne Synthesizer for Frequency Agile Radar - A.I. Vulcan and M.B. Bloch

6-41-524 Improvement of the Pull-In Range and Acquisition Time of a Microwave P.L.L System by Injection Locking the V.C.O. - J. Berenguer, J. Bara, E. Artal, I. Corbella and A. Comeron

6-41-539 High Frequency Stable Frequency Sources for Advanced Systems - A. Harrison, J. Dowsett and D. Sharpe

6-42-276 A Wide Frequency Range, Surface Mountable, Voltage Controllable Crystal Oscillator Family - S. Logan, D.M. Embree, R. Sheehey and D.S. Stevens

6-42-327 A New Digitally Temperature Compensated Crystal Oscillator for a Mobile Telephone System - T. Miyayama, Y. Ikeda and S. Okano

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6-42-342 The Relaxation Quartz Crystal Oscillators - Design & Performances - D. Vasiljevic

6-42-348 Clarification and a Generalized Restatement of Leeson's Oscillator Noise Model - B. Parzen

6-42-352 Phase Noise in Direct Digital Synthesizers - E.M. Mattison, L. Coyle

6-42-357 The Optimization of Direct Digital Frequency Synthesizer Performance in the Presence of Finite Word Length Effects - H.T. Nicholas III, H. Samueli and B. Kim

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7-11-324 Hot Sources for MASER - M.W.P. Strandberg

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7-11-352 MASER Engineering at Jet Propulsion Laboratory - W. Higa

7-11-373 Precision Atomic Beam Techniques - P. Kusch

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7-12-517 Progress in MASER Work at USASEL - F.H. Reder

7-12-534 Measurement of MASER Frequency in Terms of Cesium Standard - G.M.R. Winkler

7-12-538 MASER Research at Neuchatel University, Switzerland - J. Bonanomi

7-12-551 Beam MASER Techniques - W.H. Higa

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7-12-606 Gas Cell "Atomic Clocks" Using Buffer Gases and Optical Orientation - M. Arditi

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7-12-632 Design Considerations of Atomic Beam Frequency Standards for Missile Environment - R.T. Daly

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7-13-276 National's Militarized Cesium Beam Frequency Standards - A.O. McCoubrey

7-13-297 TRG Missile-borne Cesium Beam Standard - R.T. Daly

7-13-309 Broken Beam Experiment at Harvard University - D. Kleppner

7-13-546 Missile-borne MASER - F.H. Reder and C.J. Bickart

7-13-575 Gas MASER for Frequency Control - J.F.Lotspeich and M.L. Stitch

7-13-583 MASER Frequency Stability - J.A. Barnes and R. Mockler

7-13-596 Ammonia MASER Work at Bell Telephone Laboratories - L.D. White

7-13-603 MASERs With Slow Molecules - J.G. King

7-13-604 Suitable Molecules for Utilizing MM-Wave Transitions for Frequency Control - J.J. Gallagher

7-13-618 MASER Laboratory Frequency Standard - F.O. Vonbun

7-13-632 Triple Resonance Method to Achieve Narrow and Strong Spectral Lines - C. Alley

7-13-648 Gas Cell Frequency Standards Using Buffer Gases and Buffer Walls - R. Whitehorn

7-13-655 Evaluation of ITT Breadboard Gas Cell Frequency Standard - M. Arditi

7-13-668 Hyperfine Transitions in Rubidium 87 Vapor - E.C. Beaty, P.L. Bender and A.R. Chi

7-13-676 Gas Cell Work at the Space Technology Laboratories - D.J. Farmer, J.M. Andres and G.I. Inouye

7-13-683 Study of the Spin Relaxation of Optically Aligned Rubidium Vapor - W. Franzen

7-14-250 Work on Atomic Frequency Standards at the Nat'l Physical Laboratory during 1959-1960 - L. Essen

7-14-261 A Superior Atomic Clock for Continuous Long Time Operation - G.M.R. Winkler

7-14-298 NBS Atomic Frequency Standards - R. Mockler and R.E. Beehler

7-14-310 Molecular Beam Devices with Storage Boxes - N.F. Ramsey, D. Kleppner and H.M. Goldenberg

7-14-315 Missile-borne Atomicron Frequency Standard - A.O. McCoubrey

7-14-328 Effect of Molecular Frequency Spread on Emission Cavities - I.R. Senitzky

CATEGORY 7 (Cont'd):

7-14-329 Frequency Shifts of Microwave Resonance in a Gas Cell Using Optical Pumping - M. Arditi and T.R. Carver

7-14-330 Design Considerations for a Self-Contained Ammonia Maser Oscillator - S. Hopfer

7-14-354 Description of a Long Cesium Beam Frequency Standard - P. Kartaschoff, J. Bonanomi and J. DePrins

7-15-156 The Atomic Clock as a Phase-Stable Oscillator for Deep Space Communication - L. Malling

7-15-168 Frequency Control of NBA on an International System (II) - W.M. Markowitz and R.G. Hall

7-15-180 The Atomic Hydrogen Maser - N.F. Ramsey

7-15-181 Frequency Control by Gas Cell Standards -- Fundamental Problems in the Light of Recent Experimental Results - M. Arditi

7-15-203 The Ultimate Signal to Noise Possibilities of a Maser - I.R. Senitzky

7-15-204 Choice of a Molecular Transition for Frequency Control in the Millimeter Wave Region - F. Barnes, D. Burkhard and M. Mizushima

7-15-210 Deuterated Ammonia Submillimeter Maser - A Progress Report - V.E. Derr, J.J. Gallagher and M. Lichtenstein

7-16-256 Advances in CW Solid State Optical Masers - C.G.B. Garrett

7-16-257 Frequency Characteristics of an Optical Maser - A. Javan and T.S. Jaseja

7-16-258 Spectral Distribution of Induced and Spontaneous Emission by a Molecular Beam in a Cavity - I.R. Senitzky

7-16-259 Comparision of Performance Criteria of Frequency Standards - C.L. Searle and D.A. Brown

7-16-267 Theory of Resonance Frequency Shift Due to the Radiation Field - M. Mizushima

7-16-287 The Atomic Hydrogen Maser - N.F. Ramsey

7-16-305 Generation of Phase-Locked Millimeter Waves for Frequency Control - R.G. Strauch, R.E. Cupp, J.W. Dees and J.J. Gallagher

7-17-176 Application of Superconductivity to Frequency Control - W. Hartwig

7-17-329 Achievements and Problem Areas of Atomic Frequency Control - F.H. Reder

7-17-372 Frequency Beat Experiments with Hydrogen Masers - R.F.C. Vessot and H.E. Peters

7-17-392 Experimental Evaluation of a Thallium Beam Frequency Standard - R.E. Beehler and D.J. Glaze

7-17-408 Recent Developments in the Field of Atomic Frequency and Time Standards in Switzerland - J. Bonanomi

7-17-409 Excitation of Millimeter Wave Transitions for Frequency Control - R.G. Strauch, R.E. Cupp and J.J. Gallagher

7-17-438 Development and Performance of a Miniaturized Cesium Beam Tube - J. George

7-17-449 Performance and Application of Gas Cell Frequency Standards - D.J. Farmer

7-17-462 Report on the Frequency of Hydrogen - W.M. Markowitz

7-18-265 A Discussion of the Properties of Four Molecular Beam Detectors - F. Barnes, S.G. Andresen, C. Shipley and D. Foiani

7-18-283 Hydrogen Maser Work at USAEL - H.G. Andresen and C.J. Bickart

7-18-299 Recent Developments in Hydrogen Masers - R.F.C. Vessot, H.E. Peters and J. Vanier

7-18-308 The NPL Frequency Standard - L. Essen, J. McA. Steele and D.S. Sutcliffe

7-18-322 Recent Developments for Cesium Beam Resonators - J. George, E. Wunderer and T. Athanis

7-18-344 A Modern Solid State Portable Cesium Beam Frequency Standard - A.S. Bagley and L.S. Cutler

7-18-366 Progress in the Development of a Cesium Beam Oscillator for Aerospace Guidance - J.H. Holloway and R.H. Woodward

7-18-384 Electronic Circuits for Tri-Service Cesium Beam Frequency Standard - A. Orenberg

7-19-298 A Militarized Solid State Cesium Beam Frequency Standard - S. Fast, J. George, G. Simpson and C. Lydiard

CATEGORY 7 (Cont'd):

7-19-332 Long Time Constant Servo System for Cesium Beam Frequency Standard - H. Daams and A.G. Mungall

7-19-344 Characteristics of a High Performance Cesium Beam Frequency Standard - J.H. Holloway and R. Sanborn

7-19-369 Line Width Investigation of Millimeter Electric Resonance Molecular Beam Transitions - R.G. Strauch, R.E. Cupp, V.E. Derr and J.J. Gallagher

7-19-385 Methods and Results for Reducing Cavity Pulling Effects of the Hydrogen Maser Frequency - H.G. Andresen

7-19-402 A Comparison of Performance Characteristics of Hydrogen, Rubidium and Ammonia Masers - R.F.C. Vessot, J. Vanier, H.E. Peters and L.F. Mueller

7-19-416 Large Storage Bulb for Hydrogen Frequency Standard - N.F. Ramsey

7-19-417 The Effects of Optical Pumping on the Rb87 Maser Oscillator - P. Davidovits and W.A. Stern

7-20-364 On the Power Output of the Optically Pumped Rb87 Maser - J. Vanier

7-20-365 High-Power Maser Atomic Frequency Standards - R. Novick, W. Happer and W.A. Stern

7-20-370 Stark-Filtered Intensity-Pumped Maser Atomic Frequency Standards - W.A. Stern, W. Happer and R. Novick

7-20-377 Millimeter and Submillimeter Wave Molecular Beam Investigations - J.J. Gallagher, R.E. Cupp and R.A. Kempf

7-20-387 Recent Developments in Hydrogen Masers - N.F. Ramsey

7-20-389 Studies of Field Effect Transistors for Use in Atomic Beam Tube Detectors - J.H. Holloway and P. Penfield, Jr.

7-20-402 Servo-Controlled Hydrogen Maser Cavity Tuning - H.G. Andresen and E. Pannaci

7-20-416 A Thallium Atomic Beam Tube for Frequency Control - R.F. Lacey

7-20-424 Some Accuracy Limiting Effects in an Atomic Beam Frequency Standard - R.J. Harrach

7-20-436 The Canadian Cesium Beam Frequency Standard - A.G. Mungall, H. Daams and R. Bailey

7-20-448 Performance Characteristics of a Portable Cesium Beam Standard - L.N. Bodily

7-21-467 Molecular and Atomic Beam Geometry Optimization - J. DePrins, P.J. Wauters and S.G. Andresen

7-21-483 A New Cesium Beam Resonator - J. George

7-21-484 A Proposed Barium Oxide Molecular Beam Frequency Standard - H. Hellwig

7-21-491 Determination of the Tl205 Ground State hfs Transition Frequency - R.F. Lacey

7-21-500 Recent Developments in Atomic Hydrogen Masers - N.F. Ramsey

7-21-543 Atomic Hydrogen Maser Work at L.S.R.H., Neuchatel, Switzerland - C. Menoud, J. Racine and P. Kartaschoff

7-21-568 Recent Development on the Rubidium 87 Maser - J. Vanier

7-22-452 Large Storage Box Hydrogen Maser - E.E. Uzgiris and N.F. Ramsey

7-22-464 Hydrogen Standard Work at Goddard Space Flight Center - H.E. Peters, T.E. McGunigal and E.H. Johnson

7-22-493 Application of the Transient Behavior to the Study of the Hydrogen Maser - C. Audoin, M. Desaintfuscien and J.P. Schermann

7-22-517 Some Experimental Results of BaO Applicable to a Molecular Beam Frequency Standard - S.G. Andresen, H.O. Mortelmans, P.J. Wauters and J. DePrins

7-22-529 Barium Oxide Beam Tube Frequency Standard - H. Hellwig, R. McKnight, E. Pannaci and G. Wilson

7-22-545 Phase Shift in Microwave Ramsey Structures - R.F. Lacey

7-22-559 Study of Phenomena Affecting the Composition of Rubidium Vapor Cells - M.P.R. Thomsen, L.J. Stief and R.J. Fallon

7-22-573 Extension of Frequency Control Techniques to the Submillimeter Wavelength Region - R.A. Kempf, R.E. Cupp, W.T. Smith and J.J. Gallagher

7-22-605 Progress in the Development of Hydrogen Masers - M. Baker, M.W. Levine, L.F. Mueller and R.F.C. Vessot

7-23-263 Light Modulation at the Rb^{87} Hyperfine Frequency - H. Tank and W. Happer

7-23-271 An Optically Pumped Rb^{85} Maser Frequency Standard - W.A. Stern and R. Novick

7-23-274 A Report on the Performance Characteristics of a New Rubidium Vapor Frequency Standard - D.H. Throne

7-23-279 Improved State Selection for Hydrogen Masers - R.F. Lacey and R.F.C. Vessot

7-23-284 Recent Results Concerning the Hydrogen Maser Wall Shift Problem - E.E. Uzgiris and P.W. Zitzewitz

7-23-288 A New Method for Measurement of the Population Difference of Hyperfine-Levels of Stored Atoms - C. Audoin, M. Desaintfuscien, P. Piejus and J.P. Schermann

7-23-297 Atomic Hydrogen Standards for NASA Tracking Stations - H.E. Peters, T.E. McGunigal and E.H. Johnson

7-24-246 Areas of Promise for the Development of Future Primary Frequency Standards - H. Hellwig

7-24-259 Hydrogen Maser with Deformable Storage Bulb - P.E. Debely

7-24-263 Surface Collision Frequency Shifts in the Atomic Hydrogen Maser - P.W. Zitzewitz

7-24-270 Studies of Hydrogen Maser Wall Shift for High Molecular Weight Polytetrafluorethylene - R.F.C. Vessot and M.W. Levine

7-24-279 New Information on the Physics of Rubidium Gas Cells - P.L. Bender and V.W. Cohen

7-24-280 Progress Report on the Rubidium 85 Maser - J. Vanier, R. Vaillancourt, G. Missout and M. Tetu

7-24-285 An Optically Pumped Parametric Frequency Converter - H. Tang and W. Happer

7-24-294 Cesium Beam Servo System Using Square Wave Frequency Modulation - H. Daams

7-24-308 New Primary Cesium Beam Frequency Standard - F. Kupersmith, C. Thornburg and J. Ho

7-24-361 The NBS Atomic Time Scale System: AT(NBS), SAT(NBS), and UTC(NBS) - D.W. Allan, J.E. Gray and H.E. Machlan

7-25-46 History of Atomic and Molecular Control of Frequency and Time - N.F. Ramsey

7-25-297 Cesium Atomic Beam Frequency Standards - R.E. Beehler

7-25-309 Frequency Biases in a Beam Tube Caused by Ramsey Cavity Phase Differences - H. Hellwig, J.A. Barnes and D.J. Glaze

7-25-313 Performance of Newly Developed Cesium Beam Tubes and Standards - R. Hyatt, D.H. Throne, L.S. Cutler, J.H. Holloway and L.F. Mueller

7-25-325 A Field Independent Optically Pumped Rb85 Maser Frequency Standard - W.A. Stern and R. Novick

7-25-331 Miniaturized Rapid Warm Up Rubidium Frequency Source - M.M. Zepler

7-25-337 Discussion of Cavity Pulling in Passive Frequency Standards - J. Viennet, C. Audoin and M. Desaintfuscien

7-25-343 Hydrogen Maser Wall Shift Experiments at the Nat'l Research Council of Canada - D. Morris

7-25-348 Hydrogen Maser Frequency Standard - C. Finnie, R.L. Sydnor and A. Sward

7-26-202 Joseph H. Holloway (1929-1971) - Twenty Years of Progress in Atomic Frequency Standards - A.O. McCoubrey and L.S. Cutler

7-26-211 Automatic Frequency Controlled Rubidium Frequency Standard - Y. Sato, H. Kumamoto, H. Oyamada and H. Uchida

7-26-216 Rubidium Frequency and Time Standard for Military Environment - M.E. Frerking and D.E. Johnson

7-26-223 Further Results on the Rubidium-87 Maser Frequency Standard - W.A. Stern and R. Novick

7-26-225 Short Term Stability of Rb87 Maser - M. Tetu and J. Vanier

7-26-230 Hydrogen as an Atomic Standard - H.E. Peters

7-26-242 Experimental Results with Atomic Hydrogen Storage Beam Systems - H. Hellwig and H.E. Bell

7-26-248 Precision Absolute Frequency and Wavelength Measurements in the Infrared: A Review of Activities at MIT - J.G. Small, J.P. Monchalin, M.J. Kelly, F. Keilmann, A. Sanchez, S.K. Singh, N.A. Kurnit and A. Javan

7-26-319 Absolute Frequency of an Atomic Hydrogen Maser Clock - E.E. Peters, R.G. Hall and D.B. Percival

7-27-317 A Preliminary Report on Cs V, New NRC Long-Beam Primary Frequency and Time Standard - A.G. Mungall, R. Bailey, H. Daams, D. Morris and C.C. Costain

7-27-334 Some Performance Data for the Standards in the National Bureau of Standards Atomic Time Scale System - D.W. Allan, D.J. Glaze, H.E. Machlan, A.E. Wainwright, H. Hellwig, J.A. Barnes and J.E. Gray

7-27-347 Recent Progress on the NBS Frequency Standards - D.J. Glaze, H. Hellwig, S. Jarvis, Jr. and A.E. Wainwright

7-27-357 Time Domain Velocity Modulation as a Tool to Evaluate Cesium Beam Tubes - H. Hellwig, S. Jarvis, Jr., D.J. Glaze, D. Halford and H.E. Bell

7-27-367 Developments of Hydrogen Masers as Frequency Standards at Orsay - P. Petit, J. Viennet, R. Bartillet, M. Desaintfuscien and C. Audoin

7-27-387 A New Miniature Rubidium Gas Cell Frequency Standard - E. Jechart

7-27-390 Evaluation of a Rubidium Standard for Satellite Application - R.B. Moore, S.A. Nichols and J.D. White

7-27-400 Cavity Tuning and Light Shift in the Rb87 Maser - G. Busca, M. Tetu and J. Vanier

7-27-404 Status of the Development of the Rubidium-87 Maser Frequency Standard - W.A. Stern, E. Aulich and R. Novick

7-28-247 Atomic Frequency Standard Relativistic Doppler Shift Experiment - H.E. Peters and V.S. Reinhardt

7-28-315 Atomic Frequency Standards, A Survey - H. Hellwig

7-28-340 A Consideration of Rubidium Lamp Stability for Rubidium Frequency Standard - H. Oyamada, K. Takahashi, Y. Sato and H. Uchida

7-28-344 A Compact Rb^{87} Maser - G. Busca, J. Racine and J. Vanier

7-28-350 Mg Frequency Standard: Optimization of the Metastable Atomic Beam - F. Strumia, P. Minguzzi, M. Francesconi and R. Benedetti

7-28-355 Density-Dependent Shifts of Hydrogen Maser Standards - S.B. Crampton and H.T.M. Wang

7-28-362 Preliminary Research and Development of the Cesium Tube Accuracy Evaluation System - D.A. Howe, H.E. Bell and H. Hellwig

7-28-401 Satellite Application of a Rubidium Frequency Standard - S.A. Nichols and J.D. White

7-29-352 A New Compact Cesium Beam Frequency Standard - E.P. Graf, L.F. Johnson and R.A. Kern

7-29-357 An Improved Method for Measuring the Magnetic Inhomogeneity Shift in Hydrogen Masers - V.S. Reinhardt and H.E. Peters

7-29-362 The Concertina Hydrogen Maser - H.E. Peters

7-29-371 The Hydrogen Maser Wall Shift Problem - J. Vanier, R. Larouche and C. Audoin

7-29-383 Theoretical and Experimental Studies of Some Problems Related to the Passive Rubidium Gas Cell Frequency Standard - G. Missout and J. Vanier

7-29-387 A Digital 5.00688 MHz Synthesizer and Squarewave FM Servo System for Cesium Standards - D.A. Howe and H.F. Salazar

7-30-414 A Heuristic Model of Long-Term Atomic Clock Behaviour - D.B. Percival

7-30-451 Velocity Distribution Measurements of Cs Beam Tubes - D.A. Howe

7-30-457 Performance of a Dual Beam High Performance Cesium Beam Tube - G. Seavey and L.F. Mueller

7-30-463 Measured Performance and Environmental Sensitivities of a Rugged Cesium Beam Frequency Standard - M.C. Fischer and C.E. Heger

7-30-468 Optimization of the Buffer Gas Mixture for Optically Pumped Cs Frequency Standards - F. Strumia, N. Beverini, A. Moretti and G.D. Rovera

7-30-473 A New Kind of Passively Operating H-Frequency Standard - F.L. Walls and H. Hellwig

7-30-481 NASA Atomic Hydrogen Frequency Standards Program - An Update - V.S. Reinhardt, D.C. Kaufman, W.A. Adams, J.J. DeLuca and J.L. Soucy

7-30-489 A Study to Identify Hydrogen Maser Failure Modes - A.E. Popa, H.T.M. Wang, W.B. Bridges, A.N. Chester, J.E. Etter and B.L. Walsh

7-31-510 Design of a Spacecraft Hydrogen Maser - E.S. Sabisky and H.E. Peters

7-31-520 Hydrogen Maser with a Double Configuration Bulb for Wall Shift Measurements in the Temperature Range 25-120°C - P. Petit, M. Desaintfuscien and C. Audoin

7-31-525 A New Generation of SAO Hydrogen Masers - M.W. Levine, R.F.C. Vessot, E.M. Mattison, G.U. Nystrom, T. Hoffman and E.L. Blomberg

7-31-535 Zeeman Effects on H and Rb Masers - G. Busca, J.Y. Savard, S. Rovea, J. Vanier, M. Desaintfuscien, P. Petit and C. Audoin

7-31-542 Development of a Cesium Beam Clock for Satellite Application - J. George and A.I. Vulcan

7-31-551 New Cesium Beam Frequency Standards for Flight and Ground Applications - T.K. Gregory

7-31-555 Some Causes and Cures of Frequency Instabilities (Drift and Noise) in Cesium Beam Frequency Standards - D.W. Allan, H. Hellwig, S. Jarvis, Jr., D.A. Howe and R.M. Garvey

7-31-562 Results with Special-Purpose Ammonia Frequency Standard - D.J. Wineland, D.A. Howe and M.B. Mohler

7-32-444 Analysis of New Microwave and Optical Frequency Standards Based on Ions Storage - F. Strumia

7-32-453 New Possibilities for Frequency Standards Using Laser Cooling and Detection of Stored Ions - F.L. Walls, D.J. Wineland and R.E. Drullinger

7-32-460 A New Voltage, Maintenance-Free, Cesium Beam Tube for a Frequency Standard - H. Jumonji, K. Tanaka, J. Toyama, H. Takoaka, K. Kariya and J. Kawada

7-32-466 Parameters Affecting the Stability of an Optically Pumped Cesium Frequency Standard - G.D. Rovera, S. Leschiutta, G. Busca and F. Strumia

7-32-469 Small, Very Small, and Extremely Small Hydrogen Masers - H.E. Peters

7-32-477 Performance Evaluation of the SAO VLG-11 Atomic Hydrogen Masers - M.W. Levine, R.F.C. Vessot and E.M. Mattison

7-32-486 NASA NR Hydrogen Maser - L.J. Rueger, A.G. Bates, L. Stillman, J. Norton, C.M. Blackburn and V.A. Reinhardt

7-32-492 A Passive Hydrogen Maser Frequency Standard - F.L. Walls and D.A. Howe

7-32-499 An Operating Development Model Spcaecraft Hydrogen Maser - E.S. Sabisky and H.A. Weakliem

7-32-506 Effect of Line Inhomogeneity on the Frequency of Passive Rb^{87} Frequency Standards - A.S. Risley and G. Busca

7-32-531 Analysis of H-Maser Autotuning Systems - C. Audoin, P. Lesage, J. Viennet and R. Barillet

7-32-560 NTS-2 Cesium Frequency Stability Results - T.B. McCaskill, J.D. White, S. Stebbins and J.A. Buisson

7-33-477 Study of the Dependence of Frequency Upon Microwave Power of Wall-Coated and Buffer-Gas-Filled Passive Rb^{87} Frequency Stanards - A.S. Risley, S. Jarvis, Jr. and J. Vanier

7-33-484 Development of a Light Weight, Military, Cesium Standard - I. Pascaru and M.P. Meirs

7-33-490 New Cesium Beam Tube Utilizing Hexapole / Double-Dipole Optics - D.A. Emmons and P.J. Rogers

7-33-511 Research With a Cold Atomic Hydrogen Maser - R.F.C. Vessot, E.M. Mattison and E.L. Blomberg

7-33-515 Amplitude Noise in Passively and Actively Operated Masers - P. Lesage, C. Audoin and M. Tetu

7-33-536 Hydrogen Frequency Standard Using Free-Induction Technique - H.T.M. Wang

7-33-543 Compact Cavity for Hydrogen Frequency Standard - H.T.M. Wang, J.B. Lewis and S.B. Crampton

7-33-549 Design, Construction and Testing of a Small Passive Hydrogen Maser - E.M. Mattison, E.L. Blomberg, G.U. Nystrom and R.F.C. Vessot

7-33-554 A Small Passively Operated Hydrogen Maser - D.A. Howe, F.L. Walls, H.E. Bell and H. Hellwig

7-33-563 "Passive H Maser" - G. Busca and H. Brandenberger

7-34-320 Longevity Performance of Cesium Beam Frequency Standards - A.C. Johnson, M.M. Force and T.N. Osterdock

7-34-353 Mercury Ion Frequency Standard: Preliminary Results - M. Jardino, M. Desaintfuscien, R. Barillet, J. Viennet, P. Petit and C. Audoin

CATEGORY 7 (Cont'd):

7-34-360 New Hydrogen Maser Designs - H.E. Peters

7-34-364 An Oscillating Compact Hydrogen Maser - H.T.M. Wang

7-34-370 Results of the Development of the Light Weight Cesium Standard - M.P. Meirs, I. Pascaru and M.B. Bloch

7-34-376 Possible Avenues of Improvement of the Short and Long Term Stability of Optically Pumped Passive Rubidium Frequency Standards - L.G. Bernier, A. Brisson, M. Tetu, J.Y. Savard and J. Vanier

7-35-602 Proposed Stored $^{201}Hg^{+}$ Ion Frequency Standards - D.J. Wineland, W.M. Itano, J.C. Bergquist and F.L. Walls

7-35-612 Optical Pumping by Lasers in Atomic Frequency Standards - L.L. Lewis and M. Feldman

7-35-625 Preliminary Investigation of a New Optically Pumped Atomic Rubidium Standard - M. Feldman, J.C. Bergquist, L.L. Lewis and F.L. Walls

7-35-637 Development of a Sapphire Lamp for Use in Satellite-borne Atomic Rubidium Clocks - T.C. English and E. Jechart

7-35-646 A Miniature, High-Performance Rubidium Frequency Standard - T. Hashi, K. Chiba and C. Takeuchi

7-35-651 Performance of the GPS Cesium Beam Frequency Standard in Orbit - M.W. Levine

7-35-657 Long Term Performance of VLG-11 Masers - J.D. White and K. McDonald

7-35-662 Feasiblity of Extremely Small Hydrogen Masers - H.E. Peters

7-36-223 A Squarewave F. M. Servo System with Digital Signal Processing for Cesium Frequency Standards - Y. Nakadan and Y. Koga

7-36-230 Performance Characteristics of Cesium Beam Tube Electron Multipliers - E.R. Straka

7-36-236 A Cesium Beam Frequency Standard with Microprocessor Control - R.M. Garvey

7-36-240 Experimental Results of the Light-Weight Hydrogen Maser Development Program - H.E. Peters

7-36-249 Characteristics of Oscillating Compact Hydrogen Masers - H.T.M. Wang

7-36-255 The Development of a Magnetically Enhanced Hydrogen Gas Dissociator - L. Maleki

7-36-260 Preliminary Measurements on EFOS 1 H Maser - G. Busca, F. Addor, F. Hadorn, G. Nicolas, L. Prost, H. Brandenberger, P. Thomann and L.F. Johnson

7-36-340 Short-Term Frequency Stability and Systematic Effects on the Rubidium 87 Maser Oscillator Frequency - M. Tetu, P. Tremblay, D. Bonnier and J. Vanier

7-36-348 On the Lightshift and Buffer Gas Shift in Passive Rubidium Frequency Standards - J. Vanier, R. Kunski, P. Paulin, J.Y. Savard, M. Tetu and N. Cyr

7-37-5 History of Atomic Frequency Standards - N.F. Ramsey

7-37-6 Pulsars: Nature's Most Precise Clocks - J.H. Taylor

7-37-7 Application of Metal Hydrides for Gas Handling in Hydrogen Masers - H.T.M. Wang

7-37-12 Compact Rectangular Cavity for Rubidium Vapor Cell Frequency Standards - H.E. Williams, T.M. Kwon and T. McClelland

7-37-18 Improved Vibration Performance in Passive Atomic Frequency Standards by Servo-Loop Control - T.M. Kwon and T. Hahn

7-37-21 Ultra-Stable Laser Clock, Second Generation - R.L. Facklam

7-37-27 Microprocessor for the NR Series of Hydrogen Maser Frequency Standards - E.E. Mengel and D.W. Stover

7-37-32 Mercury-199 Trapped Ion Frequency Standard: Recent Theoretical Progress and Experimental Results - L.S. Cutler, R.P. Giffard and M.D. McGuire

7-37-37 Laser Cooled Be Accurate Clock - J.J. Bollinger, W.M. Itano and D.J. Wineland

7-37-42 Performance of Compact Hydrogen Masers - A. Kirk

7-37-49 Cold Hydrogen Maser Research at SAO and Related Developments - R.F.C. Vessot, E.M. Mattison and E. Imbier

7-38-387 Lifetime and Reliability of Rubidium Discharge Lamps for Use in Atomic Frequency Standards - C.H. Volk, R.P. Frueholz, T.C. English, T.J. Lynch and W.J. Riley

CATEGORY 8:

Quantum Electronic Frequency Standards (Visible and Infrared Frequencies)

8-15-225 The Optical Maser - W. Kaiser

8-17-425 Frequency Standards in the Optical - Range - G. Gould

8-21-455 Techniques for Generating, Detecting and Phase Stabilizing Submillimeter Coherent Radiation - G.W. Bechtold, V.E. Derr and W.T. Smith

8-23-305 Frequency Mixing and Multiplication in the Far Infrared and Infrared - A. Javan

8-23-306 Pressure Shift and Broadening of Methane Line at 3.39 Micron Studied by Laser-Saturated Molecular Absorption - R.L. Barger and J.L. Hall

8-23-307 Stability Investigations of HCN Laser - V.J. Corcoran, R.E. Cupp and J.J. Gallagher

8-23-312 Laser Frequency Stabilization Using a Primary Frequency Reference - S. Ezekiel

8-24-233 Laser Frequency Stabilization Techniques and Its Applications - H.S. Boyne

8-24-240 Automatic Frequency Control and Phaselocking of Lasers - V.J. Corcoran, R.E. Cupp and J.J. Gallagher

8-24-275 Frequency Stabilization of CO_2 Lasers with Respect to Passive SF_6 and CO_2 Line Centers - P. Rabinowitz, R. Keller and J.T. LaTourrette

8-26-250 A Stabilized HCN Laser for Infrared Frequency Synthesis - J.S. Wells

8-27-376 Characteristics of the 644 nm He-Ne Laser Stabilized by Saturated Absorption in Iodine Vapour - A.J. Wallard

8-27-382 Molecular Beam Stabilized Laser - L.A. Hackel, D.C. Youmans and S. Ezekiel

8-27-386 Influence of Hyperfine Structure of Methane Stabilized He-Ne Laser - C. Borde and J.L. Hall

8-28-348 Infrared Rectification and Frequency Mixing in a Thin Film Metal, Metaloxide, Metal Diode Structure - A. Javan and J.G. Small

8-29-316 Frequency Stabilization of a CW Dye Laser and Laser Saturation of Atomic Beams - R.L. Barger, T.C. English and J.B. West

8-29-328 High Speed Rectifying Junctions in the Infrared Regions: Recent MIT Developments - A. Sanchez

8-29-330 Frequency Stabilization of CO_2 Lasers - C. Freed

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8-29-344 Limitations on Miniature Molecular Frequency Sources - J.J. Gallagher

8-31-574 Detecting and Mixing at FIR/Submillimeter Wavelengths With Submicron Size Schottky Barrier Diodes - M. McColl, D.T. Hodges, A.B. Chase and W.A. Garber

8-31-578 A Narrow Output Linewidth Multiplier Chain for Precision Frequency Measurement in the 1 THz Region - E. Bava, A. DeMarchi and A. Godone

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8-31-592 Progress in CO_2 Laser Stabilization -C. Freed

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8-31-605 Frequency Modulation of a Far Infrared CH_3F Laser by Stark Effect - R. Benedetti, A. Di Lieto, M. Inguscio, P. Minguzzi, M. Tonelli and F. Strumia

8-31-612 The Trapped Mercury Ion Frequency Standard - M.D. McGuire

8-32-439 Saturated Absorption Optical Ramsey Fringes - J.C. Bergquist, R.L. Barger and D.J. Glaze

8-33-494 Laser to Microwave Frequency Division Using Synchrotron Radiation II - J.C. Bergquist and D.J. Wineland

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9-12-648 Comparison of Atomichrons with British Cesium Beam Frequency Standard - A.O. McCoubrey, J.H. Holloway, W. Mainberger, F.H. Reder, G.M.R. Winkler, L. Essen and J.V.L. Parry

9-12-665 Comparison of Atomic and Astronomical Time - W.M. Markowitz

9-13-316 The System of Atomic Time, A.1 - W.M. Markowitz

9-13-318 Atomic Frequency Standards for Propagation Studies - J.A. Pierce

9-13-342 Synchronized Clock Experiment - R. Bridgham, F.H. Reder and G.M.R. Winkler

9-14-254 Preliminary Results on Project WOSAC - G.M.R. Winkler and F.H. Reder

9-14-267 Results of GBR Experiment - J.A. Pierce

9-14-275 Stabilization of VLF Transmissions at NBA - H.F. Hastings and W.M. Markowitz

9-14-276 Timing Potential of Loran-C - G. Hefley, R.F. Linfield and R.H. Doherty

9-15-226 Final Results of a World-Wide Clock Synchronization Experiment (Project WOSAC) - F.H. Reder, P. Brown, G.M.R. Winkler and C.J. Bickart

9-16-227 Synchronization of Local Frequency Standards with VLF Transmissions - R.R. Stone, Jr.

9-16-249 Time Keeping Satellites - R.H. Dicke

9-16-250 Theory of Time Keeping in Space - R.K. Sachs

9-18-251 High Precision Frequency and Clock Synchronization Techniques on an International Basis - W.M. Markowitz

9-18-395 VLF Frequency Synchronization Provided with FSK Capability - R.R. Stone, Jr. and T.H. Gee

9-19-195 A Report on the Hewlett-Packard Flying Clock Experiment Number Two - L.N. Bodily

9-19-297 Clock Synchronization Via Relay II, Preliminary Report - W.M. Markowitz and C.A. Lidback

9-20-577 A Digital Servo for Frequency and Time Scale Conversion - P. Kartaschoff and H. Brandenberger

9-20-588 Time Synchronization of Remote Clocks Using Dual VLF Transmissions - A.R. Chi and S.N. Witt, Jr.

9-20-612 VLF Envelope Timing Experiment - D. Himes

9-20-613 Use of Loran-C for Timing and Frequency Comparison - L.D. Shapiro

9-21-509 Frequency Comparison System for Spacecraft Relativity Experiment - D. Kleppner

9-22-383 Recent Improvements in the U. S. Naval Observatory Timekeeping and Time Distribution Operations - G.M.R. Winkler

9-22-384 Clock Error Statistics as a Renewal Process - G.E. Hudson and J.A. Barnes

9-22-419 Results of Differential Omega Test and Evaluation Program - J.R. Wright

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9-23-236 Use of the Loran-C System for Time and Frequency Dissemination - P.E. Pakos

9-23-248 An Application of Statistical Smoothing Techniques on VLF Signals for Comparison of Time Between USNO and NBS - A. Guetrot, D.W. Allan, L.S. Higbie and J. Lavanceau

9-23-249 A Coordinate Frequency and Time System - G.E. Hudson, D.W. Allan, J.A. Barnes, J. Lavanceau, R.G. Hall and G.M.R. Winkler

9-24-315 Time/Frequency Technology in System Development - R.E. Perkinson

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9-24-325 Time and Frequency Transfer Via Microwave Link - D.E. Phillips, R.E. Phillips and J.J. O'Neill

9-24-332 Diurnal Phase of VLF Signals Near Antipode of a Transmitter - A.R. Chi

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9-25-195 Precision and Accuracy of Remote Synchronization Via Portable Clocks, Loran-C, and Network Television Broadcasts - D.W. Allan, D.D. Davis, B.E. Blair and H.E. Machlan

9-25-209 Methods of Local Time and Frequency Transfer - D.H. Phillips, R.E. Phillips, J.A. Bowman and J.J. O'Neill

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9-27-304 Accuracy of Overland Radio Location System at Fort Hood Using 1.5 to 2.0 MHz Frequency Region - J.R. Wright

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11-17-312 Spurious Modes in AT-Cut Quartz Crystals - A.E. Anderson

11-17-314 Temperature Testing Tight Tolerance Crystal Units - G.K. Bistline, Jr.

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11-33-189 Quartz Crystal Measurements by a 'Phase-Amplitude' Method - W.D. Beaver, W.E. Van Loben Sels and M. Wang

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11-35-263 The Quartz Resonator Automatic Aging Measurement Facility - D.E. Beetley, B.R. Blitch and T.M. Snowden

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11-35-280 An Automated Resonator Measurement System Using a Reflection Coefficient Bridge - R.C. Smythe

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11-36-297 New Method for the Measurement of Quartz Crystal Resonator Parameters - R.C. Peach, A.J. Dyer, A.J. Byrne and S.P. Doherty

11-36-302 An Instrument for Automated Measurement of the Angles of Cut of Doubly Rotated Quartz Crystals - J.L. Chambers

11-36-314 Performance of an Automated High Accuracy Phase Measurement System - S.R. Stein, D.J. Glaze, J. Levine, J.E. Gray, D. Hilliard, D.A. Howe and L. Erb

11-36-321 A Frequency Domain Reflectometer for Quartz Resonator Investigations - C.S. Stone and O.J. Baltzer

11-36-480 Theoretical and Practical Effects of the Resonator Specifications and Characteristics upon Precision Crystal Oscillator Design and Performance - B. Parzen

11-37-187 Improvements of Laser Interferometric Measurement System of Vibration Displacements - T. Adachi, M. Okazaki and Y. Tsuzuki

11-37-275 An Instrument for Automated Measurement of the Angles of Cut of Doubly Rotated Quartz Crystals - J.L. Chambers

11-37-284 A Measurement Technique for Determination of Frequency vs Acceleration Characteristics of Quartz Crystal Units - D.J. Healey III, H. Hahn and S. Powell

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11-37-297 A New Frequency for Piezoelectric Resonator Measurement - W.H. Horton and R.C. Smythe

11-37-300 Measuring Method of Equivalent Series Capacitance and Negative Resistance of Quartz Crystal Oscillator Circuits - M. Toki, Y. Tsuzuki and T. Mitsuoka

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11-39-535 Investigation of Quartz Crystal Thickness Shear and Twist Modes Using a New Noninterferometric Laser Speckle Measurement Method - S. Hertl, E. Benes, L. Wimmer and M. Schmid

11-39-544 A Study of Flexural, Anharmonic and Thickness-Shear Modes of Vibrations in Quartz Resonators Using Scanning Electron Microscope - H. Bahadur and R. Parshad

11-40-295 Group Delay Measurements - A Sensitive Method For Detecting Spurious Crystal Resonances - F.K. Euler

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11-40-313 The Precise Determination by an Automatic System on the Resonance Frequencies of the Quartz Crystal Resonator - Y. Oomura and Y. Watanabe

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11-41-466 Review of the Revised Military Specification for Quartz Crystal Oscillators - S. Schodowski and V.J. Rosati

11-41-527 Progress Report on the EIA/P.11 Round Robin Crystal Measurements Experiment - W.L. Smith

11-42-304 A Simple Way of Characterizing High Q Oscillators - J. Goldberg

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11-42-419 Standard Terminology for Fundamental Frequency & Time Metrology - D.W. Allan, H. Hellwig, P. Kartaschoff, J. Vanier, J.R. Vig, G.M.R. Winkler and N.F. Yannoni

11-42-432 Extending the Range and Accuracy of Phase Noise Measurements - F.L. Walls, A. Clements, C.M. Felton, M. Lombardi and M. Vanek

11-42-442 Technique for Measuring the Acceleration Sensitivity of SC-Cut Quartz Resonators - M. Watts, E.P. EerNisse, R.W. Ward and R.B. Wiggins

11-42-456 Precise Measurements of Quartz Crystal Units by Network Analyzer Technique Applied to Two Different Types of Test Jig - V. Popovic-Milovanovic, B. Dobnikar and V. Popovic

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12-16-448 Measurements on Oscillator Stability Improvement by Means of High Purity Nickel Cathode Tubes - C.J.G. Abom

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12-28-160 Relations Between Spectral Purity and Frequency Stability - J. Rutman

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12-28-243 A Method for Estimating the Frequency Stability of an Individual Oscillator - J.E. Gray and D.W. Allan

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12-41-507 Random Noise in Digital Gates and Dividers - D.E. Phillips

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12-42-389 Burst Noise and 1/F Noise in Quartz Crystals and Oscillators - G. Moulton

12-42-397 Resonator Surface Contamination - A Cause of Frequency Fluctuations? - Y.K. Yong and J.R. Vig

12-42-426 Noise and Time and Frequency --- A Potpourri - J.A. Barnes

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13-36-265 The Torsional Tuning Fork as a Temperature Sensor - R.J. Dinger

13-36-290 New Quartz Resonators with Precision Frequency Linearity over a Wide Temperature Range - M. Nakazawa, H. Ito, A. Usui, A.D. Ballato and T.J. Lukaszek

13-37-248 Force Sensor Using Double-Ended Tuning Fork Quartz Crystals - S.S. Chuang

13-38-233 Force Sensing Using Quartz Crystal Flexure Resonators - W.C. Albert

13-38-240 Stress-Compensated Quartz Resonators Having Ultra-Linear Frequency-Temperature Responses - M. Nakazawa, H. Yamaguchi, A.D. Ballato and T.J. Lukaszek

13-39-556 Enhanced Composite Resonator Analysis and its Application to the Quartz Crystal Microbalance - E. Benes, K.C. Harms and G. Thorn

13-39-571 Transient Analysis of Piezoelectric Transducer Response - A.H. Banah

13-39-575 A Filled Thermal System Utilizing A Gas Density Sensing Quartz Crystal Tuning Fork - R.W. Ward and E.P. EerNisse

13-40-211 A Quartz Fluid Density Sensor Pressure Transducer - R.W. Ward and E.P. EerNisse

13-40-216 A Resonator Temperature Transducer with No Activity Dips - E.P. EerNisse and R.B. Wiggins

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13-40-230 Double-Ended Tuning Fork Quartz Acelerometer - W.J. Kass and G.S. Snow

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13-41-333 New Prospects for Acoustic Sensors: An Overview - R.M. White

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13-41-344 A Reduced Hysteresis, Extended Range Quartz Pressure Transducer - R.W. Ward and E.P. EerNisse

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CATEGORY 14:

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14-12-624 Experimental Tests of Special and General Relativity by Accurate Timing Devices - C.H. Townes

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14-13-542 Induced and Spontaneous Emissions in a Coherent Field - I.R. Senitzky

14-13-543 A Relativity Experiment with MASERs - J. Cedarholm

14-13-629 Time Scales in the Structure of the Universe - R.H. Dicke

14-13-697 Frequency Control Research and Development in Western Europe - J.C.B. Missel

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14-16-241 Frequency Control Research and Development in Western Europe - U.E. Adelsberger

14-18-5 Professor Cady's Work in Crystal Physics - H. Jaffe

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14-18-43 Piezoelectricity - Frequency Control - R. Bechmann

14-19-59 The Increasing Applications of Tuning Forks and Other Vibrating Metal Resonators in Frequency Control Systems - F. Dostal

14-20-70 Crystals And Filters - The State-of-the-Art in Europe - W.J. Young

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14-24-13 Introductory Session Honoring Rodger Sykes on His Retirement - J.M. Wolfskill

14-24-172 A Report on IEC Technical Committee TC-49 - C. Franx

14-25-1 A Quarter Century of Progress in the Theory and Development of Crystals for Frequency Control and Selection - E.A. Gerber and R.A. Sykes

14-26-1 An Overview of Electronic Equipment Reliability - A.W. Rogers

14-28-57 Technical Aspects of Crystal Wrist Watches - H. Yoda and N. Horie

]14-31-1 Opening Remarks - V.L. Friedrich

14-33-1 The Sesquicentennial of the First Crystal Plate Equations - R.D. Mindlin

14-33-4 Relativity and Clocks - C. Alley

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14-33-47 The Domestic and International Use of the Radio Spectrum - D.M. Jansky

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14-34-510 Precision Frequency Control and Selection - A Bibligraphy, continued - E.A. Gerber

14-35-1 Opening Remarks MG - E. Paige, Jr.

14-35-3 A History of the Quartz Crystal Industry in the USA - V.E. Bottom

14-35-576 The Future of the Quartz Crystal Industry - Worldwide - A.D. Ballato

14-35-583 The Future of the Quartz Crystal Industry - Worldwide - J.H. Staudte

14-35-592 The Future of the Quartz Crystal Industry - Worldwide - W.H. Horton

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14-35-595 The Future of the Quartz Crystal Industry - Worldwide - R. Fischer

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14-36-220 "Atomic Clocks": Preview of an Exhibit at the Smithsonian - P. Forman

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14-40-1 IN MEMORIAM - Jerrold R. Zacharias

14-40-2 IN MEMORIAM - Eduard A. Gerber

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14-40-9 Quartz Crystals Paved the Way - W.L. Doxey

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14-40-24 The Atomichron - 30 Years Ago - R.T. Daly

14-41-1 Award Presentation - 1987

14-41-2 Millisecond Pulsar Rivals Best Atomic Clock Stability - D.W. Allan

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14-42-540 High-Temperature Superconductivity: Novel Concepts, Fundamental Issues, and Frequency Control Aspects (Invited Paper) - G.J. Iafrate and T.E. Parker

14-42-545 Superconducting Resonators and High-T Materials - D. Oates, A.E. Anderson and J. Steinbeck

14-42-550 High Temperature Superconductors and Their Promise for Better Microwave Circuits (Invited Paper) - P.H. Carr and J. Derov

14-42-556 Evaluating Superconducting Resonator Materials - B.R. McAvoy, J.D. Adam and G. Wagner

14-42S-1 Background and Early Sessions of the Frequency Control Symposium - W.L. Doxey

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